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A STUDY OF VAPOR CONTROL METHODS FOR GASOLINE MARKETING OPERATIONS: VOLUME II. APPENDIX

C. E. Burkin, et al

Radian Corporation

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A STUDY OF VAPOR CONTROL METHODS FOR GASOLINE MARKETING OPERATIONS: VOLUME II - APPENDIX

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Background information is given on the size and extent of the gasoline marketing industry and the magnitude of hydrocarbon vapor emissions. The principal sources of emissions, tank truck filling at bulk terminals, service station storage tank filling and vehicle refueling are characterized. Vapor control techniques for bulk terminals are described: compression, refrigeration, absorption, adsorption, incineration, and combinations of these techniques. The two types of control systems for service stations are evaluated, vapor balance systems and vacuum assist/secondary processing systems. Test data are given.

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VOLUME II - APPENDIX

by

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April 1975

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1.0 INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
1. Oil Companies		
Amoco Oil Co. Cliff Henderson	200 E. Randolph Chicago, IL 60605 (312) 856-5574	Vapor recovery at terminals and bulk stations. Information on details of systems in use and future plans to meet regulations.
William Keller	2500 N.Y. Ave. Whiting, Indiana (219) 659-2700 Ext. 466	Vapor recovery units installed by Amoco.
Irwin Ginsburgh	Same address (219) 659-2700 Ext. 447	Vapor recovery units installed by Amoco.
Atlantic Richfield Co. Dr. Frank Chapman Research Dept.	515 S. Flower St. Los Angeles, CA 90071 (213) 486-3511	Service station size.
B. S. DiGiovanni Mgr., Environmental Engr.	Same address	Service station testing.
P. P. Moskovich Electrical Engineer	Harvey Technical Center 400 E. Sibley Harvey, IL (312) 333-3000	Service station testing
Harvey Grimes	Same address	Experience with vapor recovery units.
CENEX (Farmer's Union Central Exchange, Inc.) Oscar Spradley Mgr., Operations	P. O. Box G St. Paul, MN 55165 (612) 455-8571	Vapor recovery at terminals and bulk stations.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Cities Service Oil Co. Ancal Neal Environmental Rep. Marketing Div.	P. O. Box 300 Tulsa, OK 74102 (918) 586-3750	Vapor recovery at terminals and bulk stations. Vapor recovery at marine loading facilities.
Exxon Co., U.S.A. Belle K. Tom	Pacific Retail Region 1800 Ave. of the Stars Los Angeles, CA 90067 (213) 879-2700	Service station testing.
Walter E. MacDonald	P. O. Box 2180 Houston, TX 77001 (713) 221-6170	Supplied much information on vapor recovery systems. Helped in setting up source testing of terminal vapor recovery units.
Gordon C. Potter	Same address	Same
John Kinnaird	Same address	Same
J. B. Boatwright Mgr., Consumer and Distribution Affairs	Same Address	Service station size.
Henry H. Meredith, Jr. Consumer and Distribution Affairs	Same address (713) 221-3174	Service station size
Roy Walker Mgr., Austin terminal	Wholesale & Distribution 1127 Springdale Road Austin, TX (512) 926-4311	Visit to Austin terminal. Inspection of Edwards vapor recovery unit.
J. G. Keller Chairman, API EF-14 Task Force	District Office 3600 E. W. Highway Hyatts Washington, D. C. (202) 779-1820	EF-14 Task Force (API) activities.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Farmland Industries, Inc. John Fenley Director, Petroleum Facilities & Operations Div.	Box 7305 Kansas City, MO (816) 453-1400	Vapor recovery at bulk stations and terminals.
Gulf Oil Co. E. C. Wilson Mgr., Operations Dept.	Gulf Bldg. Houston, TX 77002 (713) 266-1756	Vapor recovery at terminals and bulk stations Referral to Director of Engineering for specifics.
E. T. Grundy Director, Engineering	Same address (713) 226-2423	Vapor recovery at terminals and bulk stations. Informative on details of systems in use and those in planning stages.
Gerald P. Thurmond Administrative V.P.	Same address (713) 226-1011	Service station size.
Husky Oil Co. of Delaware Rodney Day Mgr., Engineering and Construction	4040 E. Louisiana Ave. Denver, CO 80222 (303) 756-1511	Vapor recovery at terminals and bulk stations.
Phillips Petroleum Co. J. W. Madocks	7901 Oakport Oakland, CA (415) 569-7266	Service station source testing.
Shell Oil Co. Byron H. Stoddard Marketing Engineering, Retail Distribution, Environmental Dept.	2 Shell Plaza Houston, TX (713) 220-2502	Vapor recovery at terminals and bulk stations.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Shell Oil Co. (cont.) Robert E. Booth Marketing & Economics Dept.	2 Shell Plaza Houston, TX (713) 220-6628	Service station size.
Stephan Nemeth Marketing & Economics Dept.	Same address	Service station size.
Warren Frisbee Marketing & Economics Dept.	Same address	Service station size.
Standard Oil Co. of California Western Operations, Inc. James Presten	225 Bush St. San Francisco, CA 94104 (415) 894-2734	
H. F. Klein	Same address	All aspects of service station vapor recovery systems were discussed with Chevron. They were very informative and appeared quite willing to provide any help and information requested.
A. English	Same address	
C. R. Lupcho	Same address	
Texaco, Inc. W. T. Hutcheson General Mgr., Administration, Operations	135 E. 42nd. St. N. Y. 10017 (212) 953-6000	Vapor recovery at terminals and bulk stations. Informative on specifics of systems in use and company plans. Can be recontacted.
W. L. England Manager, Sales Dept	Same address	Service station size.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Union 76 (Union Oil of California, Western Div.) Edward Bloom Environmental Sciences Div.	P. O. Box 7600 Los Angeles, CA 90054 (213) 486-6810	Vapor recovery-terminals and bulk station. Informed as to regulation and how to meet them. No specifics as to systems in use were discussed.
Allan W. Percy Distribution Engineer	Same address	Provided information on the operation of service station vapor recovery systems. Very informative.
2. Federal Agencies		
EPA Peter Westlin	Research Triangle Park Durham, NC 27711 (919) 688-8146	Test procedures.
Winton E. Kelly	Same address	Source testing.
Robert Maxny	Mobile Source Enforcement Div. 401 M St. S. W. Washington, D. C. 20460 (202) 755-0940	Service station size data from 1967 Census of Business.
John Bonine	Office of General Council 401 M St. S. W. Washington, D. C. 20460	Legal implications of regulations for existing facilities and for new source standards.
EPA-Region 1 John L. Calgani	J. F. Kennedy Federal Bldg. Rm. 2303 Boston, MA 02203 (617) 223-4448	Regulations for HC emissions from gasoline marketing. Excellent contact and available for recontact. Well informed on regional situation.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
EPA-Region 2 David Stone Enforcement Div.	26 Federal Plaza Rm. 908 N.Y., NY 10007 (212) 264-2517	Regulations for HC emissions from gasoline marketing. Informative on details of regulations in the various states within region.
EPA-Region 3 Daniel Fitzgerald	6th & Walnut Sts. Philadelphia, PA 19106 (215) 597-9162	Regulations for HC emissions from gasoline marketing. No specifics available on regulations in this region.
EPA-Region 4 Randall Mayfield	1421 Peachtree St., N.E. Atlanta, GA 30309 (404) 526-5552	Regulations for HC emissions from gasoline marketing. Helpful contact. Recontact as required.
EPA-Region 5 Rex Dieterle Enforcement Div	1 N. Wacker Dr. Chicago, IL 60606 (312) 353-5185	Regulations for HC emissions from gasoline marketing. Informative.
EPA-Region 6 John Crocker	1600 Patterson St. Suite 1100 Dallas, TX 75201 (214) 749-2142	Regulations for HC emissions from gasoline marketing. Well informed on Texas Transportation Control Plan.
EPA-Region 7 Art Spratlin	1735 Baltimore Ave. Kansas City, MO 64108 (816) 374-3791	Regulations for HC emissions from gasoline marketing. St. Louis is the focal point in this region.
EPA-Region 8 Dale Wells	1860 Lincoln St. Suite 900 Denver, CO 80203 (303) 837-2717	Regulations for HC emissions from gasoline marketing. Denver is the focal point for HC regulations in this region.
Gregory Hobbs	Same address (303) 837-2361	Vapor recovery at bulk stations in this region.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
EPA-Region 9 Lloyd Kostow	100 California St. San Francisco, CA 94111 (415) 556-7550	Regulations for HC emissions from gasoline marketing. Referral to California Air Resource Bd., Sacramento (see State Agencies).
Fred Thoits	Same address	Service station testing.
EPA-Region 10 Lawrence Sims Air Programs Div.	1200 6th Ave. Seattle, WA 98101 (206) 442-1200	Regulations for HC emissions from gasoline marketing.
U. S. Dept. of Commerce Social & Economic Statistics Admin., Bureau of Census John Wykoff Asst. Div. Chief Bureau of the Census	14th St. Washington, D. C. 20233 (301) 763-7644	Availability of 1972 Census of Business. Arrangements were made for Radian to obtain final statistics via telephone as soon as they are available through the help of Mr. Wykoff.
Bureau of Census, Retail Trade Robert Russell Division Head	Same address (301) 763-5282	1972 Census of Business Retail Trade Statistics. Source of 1972 statistics as they are available.
Bureau of Census, Wholesale Trade John Kuntz Division Head	Same address	1972 Census of Business, Wholesale Trade. Source of 1972 statistics as they are available.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
3. State Agencies		
California Air Resource Bd. Peter Venturini	1709 Q St. Sacramento, CA (916) 322-6038	California regulations for HC emissions. Informative-available for recontact.
Texas Air Control Bd. (TACB) James Kamrath Planning Dept.	8520 Shoal Creek Blvd. Austin, TX (512) 451-5711	Information resources of TACB for this study. Very willing to help.
Kenneth Wade Regulations Div.	Same address	Ship and barge regulations. Informative on details of Texas regulations and compliance schedules.
Davis Scharff	Same address	Marine vapor recovery controls. Very informative.
Frank Spuhler	Same address	Marine vapor recovery controls.
San Diego County APCD B. R. McEntire Air Pollution Engineer	Dept. Public Health 1600 Pacific Highway San Diego, CA 92101 (714) 236-3826	Marine vapor recovery controls. Experience with service station vapor recovery systems.
Ray Skoff Air Pollution Engineer	Same address	Service station testing.
Andrew Segal	Same address	Information resources. San Diego Co. APCD Index of Information is to be made available to Radian.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Colorado State Health Dept., Air Pollution Control Ernest Tronco	4210 E. 11th Ave. Denver, CO (303) 388-6111	Colorado regulation for HC based on mass emissions and Denver AQCR Transportation Control Plans. Available for discussion of specific points.
Los Angeles County APCD Janet Dickinson	434 S. San Pedro St. Los Angeles, CA 90013 (213) 629-4711	Information sources. Good source of reports and papers.
John Nevitt	Same address	Regulations for HC emissions in Los Angeles County. A member of API Task Force EF-14, Mr. Nevitt is a good contact and will be glad to respond to specific written questions.
Robert Murray	Same address (213) 974-7461	Vapor recovery at marine terminals, source testing procedures at bulk terminals, and vapor recovery units at terminals in this APCD.
Bay Area APCD James Talbot	939 Ellis St. San Francisco, CA 94109 (415) 771-6000	Very informative, especially during discussions of service station source testing procedures. Helped set up Haywood and Davis tests.
Fred V. Hall Air Pollution Engineer	Same address	Same
Gale G. Karels Chief of Source Test	Same address	Same
Thomas Perardi	Same address	Source testing operations of service station and terminals. Very helpful and informative in areas of problems associated with source testing of terminals.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
4. Trade Associations-Company Sponsored		
American Petroleum Institute (API) Richard Southers Marketing Div., Operations & Engineering Coordinator	1801 K. St. N. W. Washington, D. C. (202) 883-5600	Task Force EF-14 for gasoline vapor control at marketing facilities.
A. R. Rescorla Asst. Dir., Environmental Affairs	Same address	Task Force EF-14 for gasoline vapor control at marketing locations.
Brice Cecil Asst. Dir., Marketing Div.	Same address	Marketing, data, projections, attitudes.
National Oil Jobbers Council Douglas Mitchell Executive Secretary	1701 K St. N. W. Washington, D. C. 20006 (202) 331-1198	Vapor recovery, and position of jobbers with vapor controls
William Quortrup Committee Chairman, Vapor Control Methods	P. O. Box 672 Carrollton, TX 75006 (214) 242-6411	Activities of this group and statistics available through them.
National Petroleum Refiners Assn. Herb Bruck Technical Director	Suite 802 1725 DeSales St. Washington, D. C. 20030 (202) 638-3722	Vapor control activities.
Howard Darling Vice President	Same address	Vapor control activities.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Petroleum Equipment Institute Howard Upton Executive Vice President	1579 E. 21st St. Tulsa, OK 74114 (918) 742-8632	Gasoline marketing-vapor collection.
Texas Oil Marketers Assn. Calvin S. McIntosh Executive Vice President	P. O. Box 1424 Austin, TX 78767 (512) 476-9547	Activities in marketing of gasoline, others.
SIGMA Richard Reynolds Exec. Secretary	230 S. Bemiston Suite 909 St. Louis, MO (314) 721-6723	Activities and available statistics on this group.
National Fire Protection Assoc. NFPA-30 Paul A. Mankin Member NFPA-30 Committee	Bennett Pump Broadway & Wood St. Muskegon, MI (616) 733-1302	Discussion of committee work as it pertains to gasoline marketing.
5. Equipment Manufacturers		
Betz Environmental Engineers James H. Geiger	One Plymouth Mtg. Hall Plymouth Meeting, PA (215) 825-3800	Source testing and data analysis.
Francis J. Boinski	Same address	Source testing and data analysis.
Peter Charrington	Same address	Source testing and data analysis.
Calgon Corporation Richard A. Fusco Development Engineer	Box 1346 Pittsburgh, PA 15230 (412) 923-2345	Testing of vapor recovery units.
Bernard L. Grandjacques Development Engineer	Same address	Testing at vapor recovery units.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Chikshan Gene Wheeler Loading Div.	332 N. Brea Blvd. Brea, CA (714) 529-2121	Availability of equipment for marine vapor recovery units.
Clean Air Engineering Marvin Stary Vice President	2851 White Star Ave. Anaheim, CA (714) 630-6700	Vapor recovery units for service stations.
Edwards Engineering Co. Ray Edwards	101 Alexander Ave. Pompton Plains, NJ (201) 835-2808	Operation and development of Edwards unit. Very informative and helpful.
Norman Watt	Same address	Same
Emco-Wheaton Allen M. Bower Vice President, Engineering	Chamberlain Blvd. Conneaut, OH (216) 599-8151	Vapor return fittings.
David T. Fenton	Same address	Emco-Wheaton nozzles.
W. L. Moore Western Sales Mgr.	Apt. L307 Newport Beach, CA 92660 (714) 645-7324	Emco-Wheaton nozzles
Environics Y. C. Lee President	7424 Lorge Circle Huntington Beach, CA (714) 842-8836	Vapor recovery units for service stations.
Environmental Integrity Co. (E.I.C.) Duane Sceper	P. O. Box 80445 San Diego, CA (714) 459-7438	Vapor recovery units for service stations.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Firestone Jerry Klavon Marketing Mgr., Fuel Tank Div.	Magnolia, Ark. (501) 234-3381	Collapsible rubber fuel tanks.
Fischer and Porter Instrument Co. John Kopp	Warminster, PA (215) 675-6060	Flow measuring controls.
General Atomic Co. (GESCO) Gerard Mowbray Mgr., Vapor Recovery Systems	P. O. Box 81608 San Diego, CA (714) 453-1000 ext. 811	Vapor recovery units for terminals.
Hazlett Enterprises Wesley Hazlett	1089 Indian Village Rd. Pebble Beach, CA 93953 (408) 372-4692	Hazlett vapor recovery system. Provided a P-V valve for service station testing. Very informative.
Hydrotech James McGill Engineer	P. O. Box 45042 Tulsa, OK (918) 622-1066	Vapor recovery units.
Intermark Industries, Inc. R. W. Taylor President	1300 S. State College Blvd. Anaheim, CA 92806 (714) 991-1330	Vapor recovery units.
OPW (Dover Corp.) Robert C. Carl Vice President, Engineering	2735 Colerain Ave. Cincinnati, OH (513) 541-5400	Very informative on aspects of nozzle manufacturing and design. Active participants in the source testing program.
R. L. Murray Mgr., Product Development	Same address	Same
Glen More Vice President, Sales	Same address	Equipment cost data.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
Process Products Joseph Stuart	16921 Southwestern Ave. Gardenia, CA (213) 770-1905	Vapor recovery units for service stations
William Martial	Same address	Energy requirements for vapor recovery units.
Parker-Hannifin Co. Richard Cisco Marketing Dept.	18821 Jamboree Blvd. Irvine, CA 92664 (714) 833-3000	Vapor recovery units.
Rheem-Superior Rex Vicars Mgr., Houston Sales Office	P. O. Box 14228 Houston, TX (713) 485-2771	Vapor recovery units.
Reinke Associates Ted Reinke	Pompton Paines, NJ (201) 441-1236	Sales of Edwards vapor recovery units.
Southwest Industries (Ingersoll-Rand) John Halvorsen	P. O. Box 19188 Houston, TX 77024 (713) 467-2221	Vapor recovery units.
Uniroyal Phillip Winslow Sales Div.	1232 Ave. of Americas New York, NY 10020 (212) 247-5000	Uniroyal hoses
Bush Rodenbach	Mishawaka, IN 46544 (219) 255-2181 Ext. 706	Research into auto bladders.
Vaporex Peter Prentice Marketing Div.	900 Orangefair Lane Anaheim, CA (714) 879-333	Vapor recovery units for service stations.
Ed Edwards Chief Engineer	Same address	Vapor recovery units for service stations.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
6. National Petroleum News and Special Survey Publishers		
National Petroleum Marion Hemingway Research Manager	1221 Ave. of the Americas New York, NY (212) 997-2316	Data for Factbook issues.
Cornelius Broderson Operations/Equipment/ Fuel Oil Editor	Same address	Vapor recovery regulations.
Audits and Surveys, Inc. Allan Beyer	New York, NY (212) 689-9400	Press Release on number of service stations. Details on retail census performed by Audits & Survey.
Lundberg Survey, Inc. Kenneth Cox	Beverly Hills, CA (213) 768-5111	Statistics available for gasoline marketing.
7. Technical Experts		
Dr. F. A. Williams	Univ. of California at San Diego (714) 453-2000 Ext. 1609	San Diego, Co. APCD Index of Information referred to in Dr. Williams report entitled Technical Review and Evaluation of Vapor Control Systems. A good contact for technical information related to the study which culminated in the report mentioned above.
Dr. R. A. Nichols	Parker-Hannifin Co. 18821 Jamboree Blvd. Irvine, CA 92664 (714) 833-3000	Status of emission factor study. Design parameters that influence recovery efficiencies. Aided in developing the test procedure for terminals. A good technical contact on all phases of the problem. Very helpful.

INDUSTRY CONTACTS

Name and Affiliation	Address and Phone	Subjects, Comments
R. R. Perschbacher Underwriters' Labs. Asst. Managing Engineer Casualty and Chemical Hazards Dept.	333 Pfingsten Rd. Northbrook, IL 60062 (312) 272-8800	Radian's work on assessing vapor recovery systems.
John A. Gunderson Olson Laboratories Mgr., Analytical Programs and Systems Analysis	421 E. Cerritos Ave. Anaheim, CA 92805 (714) 956-5450	List of vapor recovery equipment manufacturers.

2.0 PRESURVEY TRIP REPORTS AND TEST REPORTS BY OTHERS

2.1 EXXON-Houston Terminal Visited and Reported by J. C. Dickerman

On June 7, 1974, the writer met with Mr. W. A. McDonald to tour EXXON's Almeda Road Terminal vapor recovery facilities. At this terminal EXXON has a Parker Hannifin refrigeration-compression vapor recovery unit to recover hydrocarbon vapors resulting from tank truck loading. They also have a test facility to evaluate vapor recovery controls for service stations. Both of these vapor recovery systems were visited on this tour and are discussed below.

Terminal Loading System

Tank trucks filled at this terminal are bottom loaded, and the resulting vapors are collected and sent underground to the vapor recovery system. The vapor recovery system is a Parker Hannifin unit which has been in service for several years.

The hydrocarbon vapors enter the vapor recovery unit through a saturator where the vapors become partially saturated with hydrocarbons. The vapors are compressed and cooled, then enter a low temperature absorber where the hydrocarbons in the vapor are absorbed by a spray of recirculating gasoline. Essentially hydrocarbon free air exits the top of the absorber.

Detailed information on flow rates, temperatures and pressures of the streams to and from the Parker Hannifin unit was not available; however, experience with the system indicates it should be possible to achieve about 90% hydrocarbon removal. Data on horsepower requirements and operational costs of this unit can be provided by EXXON.

There were several maintenance problems associated with this unit when it first came into service, but it now requires only minor intermittent maintenance attention. At present, according to Mr. McDonald, this unit operates at a greater than 80% stream factor.

Service Station Test Facility

The test facility consisted of an underground storage tank, a gasoline dispensing pump, and an Atlantic Engineering Unit which was used for testing vacuum assist systems. The purpose of the test facility has been the evaluation of gasoline dispensing nozzles. A gasoline tank from a 1973 Oldsmobile was also located at this test unit. The vent line on the gasoline tank could be vented directly to the atmosphere if desired to simulate conditions for prior-to-1970 model automobiles.

Other EXXON Terminal Units

Mr. McDonald described the Edwards Vapor Recovery Unit installed at EXXON's Austin, Texas terminal. The Edwards unit differs from the Parker-Hannifin in that there is no gasoline vapor compression stage. Instead, the gasoline vapors are condensed on low temperature refrigeration coils. The unit is newly installed. It is not fully lined-out and not ready for a thorough pre-survey inspection.

2.2 EXXON-Austin Terminal Visited and Reported by J. C. Dickerman and C. E. Burklin

On July 2, 1974, the writers met with Mr. Walker, the Terminal Manager, to tour the terminal vapor recovery facilities.

EXXON's Austin terminal employs an Edwards Engineering vapor recovery unit to recover hydrocarbon vapors from tank truck loading operations.

System Description

All tank trucks are bottom loaded and the resulting vapors are sent underground to the vapor recovery unit. At this terminal the driving force for vapor flow is direct displacement only.

There are currently no service stations in the Austin area utilizing vapor recovery control techniques; consequently, the vapor space in the returning tank trucks are filled with a sub-saturated hydrocarbon mixture. Hydrocarbon concentration in the vapors returned to the vapor recovery unit vary from 6% to greater than 20%, with the balance being air.

System Operations

The principle of operation of the Edwards unit is relatively simple. The tank truck vapors are passed over a refrigerated coil where the hydrocarbons and water are condensed from the vapor mixture. Essentially hydrocarbon free air exits the top of the condenser. The condensate is first pumped to a water-hydrocarbon separator where the water stream is routed to waste water treatment and the hydrocarbon stream to gasoline storage.

The refrigeration package of the Edwards unit is designed to continuously maintain the condenser coils at a preset temperature. A wide swing in vapor rates can be accomodated by the unit. A hydrocarbon vapor surge tank is not required.

At the time of our visit, the condenser was operating at -50°F although temperatures as low as -100°F can be reached. It was learned through a telephone conversation with Mr. Normal Watt, an Edwards engineer, that a series of tests to determine optimum operating conditions for this unit was planned for the near future.

System Problems and Costs

Mr. Walker was pleased with the unit operation. He indicated that it had been running for over two months with no major problems. The only problem indicated by Mr. Walker was frost buildup on the cooling coils; however, this problem had been solved by increasing the number of defrosting cycles.

The unit currently recovers about one gallon of condensed vapors per 1000 gallons of gasoline loaded. This value would, of course, increase if the hydrocarbon concentration in the tank truck vapor space were higher. According to Mr. Walker, operating costs run about $450/month. Purchase cost of the unit was $37,000. Operating costs are primarily associated with running two-30 HP refrigeration compressors.

Recommendations for Further Work

We feel this unit should be tested as part of the terminal source testing program. Considerable interest in this unit has been expressed by several major oil companies. Mr. Walker indicated that representatives from several oil companies had made inquiry about the unit, and that they were either considering ordering or had already ordered similar units. Edwards Engineering personnel indicated that an improved hydrocarbon-water separator will soon be placed on this unit. We feel testing should be conducted on this unit after equipment improvements have been completed and operations are placed on a routine basis.

2.3 San Diego-San Francisco Service Stations Visited and Reported by J. C. Dickerman

This report summarizes a June 17-21, 1974 trip to San Diego and San Francisco for the pre-survey investigation of hydrocarbon vapor recovery facilities at service stations. While in San Diego, a test of a vapor displacement type system was witnessed, and discussions were held with several persons on these systems. Meetings were held in San Francisco with Region IX EPA Bay Area Air Pollution Control District (BAAPCD) personnel to determine the times and locations of a service station source sampling trip to be conducted later in later months.

Observations of Vapor Displacement Test

The parameters measured by EPA and TRW during the test conducted at a Chevron Station at the corner of Baltimore and Lake Murray Boulevard in San Diego were similar to those proposed by the writer as necessary for material balance determinations to be included in planned service station tests. Continuous monitoring of hydrocarbon concentrations in the underground tank vent line was not performed, although this was effectively accomplished by measuring the volume of vapors lost the the weight of hydrocarbon pick-up on activated carbon.

The tests were well conducted and most measurements were made with only a small delay to participating customers. Although the time delays were small, it was evident that obtaining customers willing to participate in the testing was a problem. Several factors probably contributed to the lack of customers, some of which may have to be addressed while testing in the Bay Area. Two factors contributing most to the lack of customer participation appeared to be: (1) the service station opened only four days prior to the source test, and (2) there were always several observers standing around the gasoline dispensers which may have dissuaded customers from entering the station.

Test Procedure Comments from Other Observers

An attempt was made to include all comments relevant to vapor recovery systems from other observers in this section. Some comments from a meeting held with the BAAPCD authorities will also be included.

Many of the observers were asked what additions or deletions they would recommend to the testing procedure being used by TRW. There were only a few specific procedural changes recommended. These were: (1) include continuous monitoring of the HC concentration of the underground task vent line, and (2) add the use of a dual range explosimeter for checking nozzle-fill neck leaks. The dual range explosimeter can give a qualitative indication of the severity of a leak at the nozzle-fill neck interface. Personnel from the BAAPCD commented that the use of a flowmeter in the vapor return line to the underground tank may cause a pressure drop which could affect the design of a vapor balance system.

In general, most of the comments received offered no recommendations for change of the testing procedure. Personnel from the San Diego Air Pollution Control District (SDAPCD) did make some comments, however, which should probably be considered in future testing. They commented that the empirical method used in determining vapor losses from the nozzle-fill neck interface (establishing a base line and using it for assessing the total vapors produced) might not be acceptable due to the wide variations from the base line that can be obtained. They also commented that the flow rate of gasoline dispensed to the automobile varied from test to test, and that the flow rate of gasoline dispensed for vacuum-assist systems generally was larger than that dispensed for the displacement systems.

Miscellaneous Comments from Other Observers

Through discussions with persons at the test site, it was learned that safety evaluations and acceptance tests are presently being conducted on both vacuum assist systems and vapor return nozzles by Factory Mutual and/or Underwriters Laboratory. It was also pointed out that no acceptance testing procedures have yet been promulgated by the National Fire Protection Agency (NFPA), and it is very unlikely that a certifying test laboratory will report on a system without such guidelines.

Bob Carl from OPW commented that although their vapor recovery nozzles were in short supply, he should be able to supply any station to be tested in the Bay Area by late July with nozzles. He also said that the new type nozzles deliver lower flow rates than the older style nozzle.

A discussion was held with Mr. Ray Skoff of SDAPCD to determine his interpretation of the word "all" as stated in the San Diego Regulations. There appears to be considerable confusion as to the exact meaning of the term. The intent of the regulation, according to Mr. Skoff, was that "all" vapors were collected when the explosimeter showed no reading at the fill neck interface.

EPA Region IX Meeting

A brief conference was held at the EPA Regional Offices prior to meeting with BAAPCD personnel. The purpose of the meeting was to inform the regional personnel of the proposed service station source testing program tentatively scheduled to occur in the Bay Area. It was recommended by region personnel that a vapor displacement system developed by Hazlett Enterprises be considered for testing. This system is completely sealed and operates from a vacuum created in the underground tank. The system also has a unique ball valve system in the nozzle which is reported to be very advantageous.

Meeting with Bay Area APCD Personnel

The purpose of this meeting was to inform the BAAPCD personnel of the proposed testing of vapor balance systems to occur in the Bay Area. Assistance was solicited from BAAPCD in selecting the test sites. The following list of test sites and sampling dates was agreed upon. Oil company representatives will, of course, be contacted for concurrence.

- July 29 - August 2; An Exxon Manifolded System
- August 5 - 9; A Phillips Petroleum station utilizing the Hazlett system
- August 12 - 16; A Chevron station located at Davis, California.

A discussion on testing procedures occurred at which time the writer presented a proposed list of parameters to be observed in performing hydrocarbon material balances around vapor displacement systems. There were generally no objections to the proposed testing, but the following points were raised.

- Care should be taken when measuring the volume of vapor returned to the underground tank to assure that an unduly large pressure drop is not created.
- It would be of interest to compare hydrocarbon concentrations obtained by both a hydrocarbon monitor and by calculations from an oxygen monitor.
- It may be beneficial to utilize a bonded, certified testing laboratory, such as Charles Martin in San Francisco, to run complete analyses on the dispensed gasoline to confirm that tests are representative.
- It may be possible to determine nozzle losses by the use of a plastic bag surrounding the nozzle.

BAAPCD personnel offered to help in any way possible, and agreed to arrange publicity releases of the testing in an attempt to attract willing participants.

Recommendations for Vapor Recovery Tests

Based on discussions and observations at the service station test site on June 18 and 19, the writer developed the following recommendations for consideration in planning future service station source tests. These comments may be divided into three categories; alterations of the San Diego test procedure, other test procedures to be considered, and methods to attract customers for test participation.

1. Alterations of San Diego Test Procedures
   - The underground tank vent should be continuously monitored for hydrocarbon concentration.
   - A dual range explosimeter should be employed to check for the relative severity of nozzle-fill leaks.
   - Complete gasoline analyses should be conducted of both the dispensed gasoline and the gasoline dropped to underground storage.
2. Other Test Procedures to be Considered
   - Care should be taken to permit no pressure drop across a system that could affect the system's operability. For this reason, methods other than using a dry gas meter for measuring the amount of vapors displaced from a vehicle tank should be considered.

- The use of a vapor trap, such as a sealed plastic bag surrounding the nozzle, should be considered in evaluating nozzle losses.

3. Methods of Attracting Participating Customers

   - Publicity releases should be given a few days prior to the start of testing. BAAPCD agreed to handle this.

   - The number of observers standing at the dispenser islands should be limited to test personnel.

   - Signs should be placed at the test sites clearly indicating that a service station test is in progress and willing participants are needed.

   - Some type of incentive offered the customer to encourage his participation, such as a 5¢ per gallon reduction on gasoline.

Personal Contacts

Listed below are the names and affiliations of persons contacted during this trip. These people were very helpful to the writer in gaining a better understanding of vapor recovery system technology.

Pete Westlin - EPA
Ed Hasselmann - TRW

Tony Eggleston - TRW
Jim Presten - Chevron Oil Co.
Howard Klein - Chevron Oil Co.
Al English - Chevron Oil Co.
Bob Lupcho - Chevron Oil Co.
Bob Carl - OPW (VP-Engineering)
R. W. Taylor - Intermark (President)
Belle K. Tom - EXXON
Dick Fusco - Calgon
B. McEntire - San Diego APCD
Ray Skoff - San Diego APCD
Jim Talbot - Bay Area APCD
Fred Hall - Bay Area APCD
Gale Karels - Bay Area APCD
Tom Peraldi - Bay Area APCD
Fred Thoits - EPA Region IX

2.4 Shell Service Station - Concord, California, Visited and Reported by J. C. Dickerman and C. E. Burklin

On August 7, 1974, the writers met with Dale Size of Shell's regional marketing office, at Shell's experimental service station in Concord, California. The purpose of the meeting was to investigate Shell's vacuum assist gasoline vapor recovery system installed in the Concord service station and to assess the merits of testing the facility's vapor recovery efficiency.

System Operation

Figure 2.4-1 is a flow diagram of the vacuum assist vapor recovery system employed at Shell's experimental service station in Concord, California. The hydrocarbon vapors are collected by handmade prototype McDonald nozzles. These nozzles are equipped

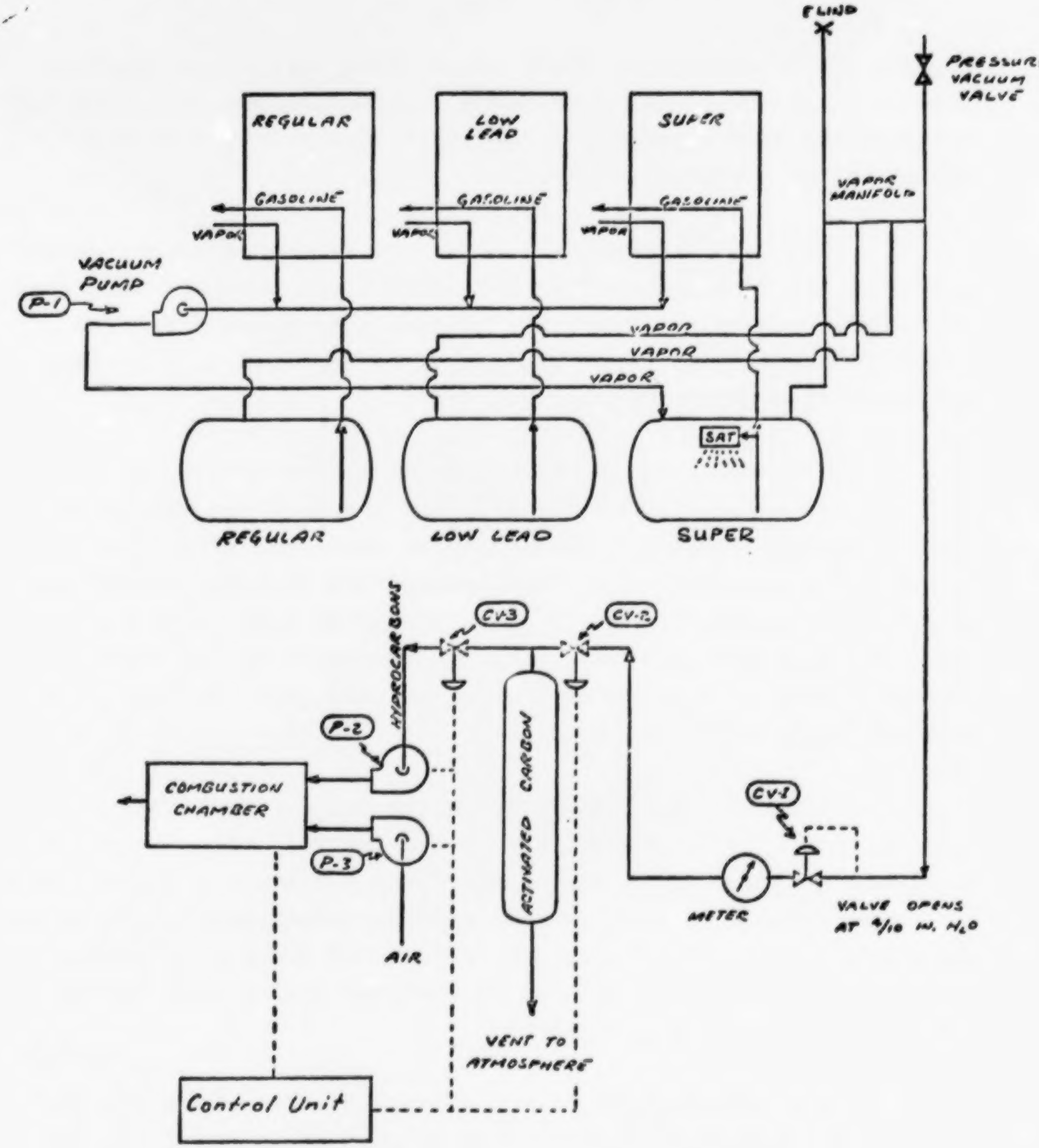
BLIND
PRESSURE VACUUM VALVE
REGULAR
LOW LEAD
SUPER
GASOLINE
VAPOR
GASOLINE
VAPOR
GASOLINE
VAPOR
VAPOR MANIFOLD
VACUUM PUMP
P-1
VAPOR
VAPOR
VAPOR
SAT
REGULAR
LOW LEAD
SUPER
HYDROCARBONS
CV-3
CV-2
P-2
COMBUSTION CHAMBER
P-3
ACTIVATED CARBON
CV-1
METER
VALVE OPENS AT 4/10 IN. H2O
AIR
VENT TO ATMOSPHERE
Control Unit

FIGURE 2.4-1 · SHELL VACUUM ASSIST

with on/off valves on the vapor lines which operate in conjunction with the throttling fuel valve. Actuating any fuel pump also actuates the vacuum pump (P-1) and maintains a 2 to 6 in H_2O vacuum in the vapor return line.

The vacuum pump (P-1) pumps the recovered vapors underground to the "Super Shell" storage tank where they are saturated for safety by a spray saturator. Excess vapors are displaced from the "Super Shell" tank via the vapor manifold to the storage tanks from which the fuel was drawn.

When the pressure in the vapor system reaches 4/10 in H_2O, control valve CV-1 opens, allowing the gasoline vapors in the underground storage system to enter the vapor oxidation system. The entering vapors are metered and then passed through an activated carbon bed where the hydrocarbon components of the gasoline vapor are adsorbed. The air component of the vapor stream is vented to the atmosphere. At this time valve CV-2 is open and valve CV-3 is closed.

After an hour of operation the carbon regeneration cycle is initiated automatically by the control unit. Valve CV-2 is closed, valve CV-3 is opened and pumps P-2 and P-3 are switched on. Air is drawn by pump P-2 through the carbon adsorption column, desorbing the adsorbed hydrocarbons. In the combustion chamber the hydrocarbon stream from P-2 is combined with an air stream introduced by P-3 and is ignited.

When the desorbed hydrocarbons have dropped below the combustible concentration, the control unit shuts off pumps P-2 and P-3, closes valve CV-3, and reopens valve CV-2. Another one hour adsorption cycle begins. The activated carbon life for this system is projected to be two years.

System Evaluation

The Shell service station in Concord is well arranged and offers ample space for the positioning of test equipment. In addition, the Shell oxidation unit is simple and very accessible for measurements.

There was some leakage at the nozzle-fill pipe interface, however. Vapors could be seen escaping from all of the five automobile refuelings observed during the pre-survey visit. The bellows-hose on the nozzle had been replaced with stiff sections of swimming pool vacuum hose. The result was a very poor nozzle-auto interface fit.

3.0 TEST REPORTS BY OTHERS - SUMMARY OF RESULTS

Nine reports of service station testing conducted by others have been reviewed. These test reports are predominantly concerned with evaluating the operation of displacement systems. Each report is briefly discussed and summarized below in the following pages. The reports reviewed are as follows:

Calgon Report - April 19, 1973 (FU-035)

Calgon Report - July 10, 1974 (GR-106)

Olson Laboratory Report - October, 1973 (OL-018)

Scott Laboratories Report (Cape 9 Study) - September 1, 1972 (SC-167)

Standard Oil of California - November 27, 1973 (ST-187)

Atlantic Richfield Report - April 8, 1974 (AT-045)

Exxon Report - May 31, 1974 (PO-100)

Scott Laboratories Report - June 26, 1973 (SC-186)

TRW Report - August, 1974 (HA-256)

Calgon Report - April 19, 1973

Test results were reported for a "displacement" system and a vacuum assist system (-0.1 → -0.5" H_2O) employing an activated carbon canister to capture excess vapors. Results indicated that the activated carbon system would control vapor emissions well in excess of San Diego's 90% requirement while the "displacement" system would be able to control approximately only 80% of the total emissions. Attempts were made to measure excess underground tank filling losses but they were unsuccessful because of tank truck leakage.

The displacement system efficiency of 80% was based on an excess vapor growth of greater than 20%. The regression line for this data is:

$$V/L = -0.007\Delta T + 1.224$$

where

V/L is the volume ratio of returned vapor to dispensed gasoline (ft^3/ft^3)

ΔT is the temperature difference in the vehicle tank temperature and the dispensed gasoline temperature.

This vapor growth is much greater than reported by other investigators. It should not be considered as a representative value, however. The results were obtained on a system that is not typical of displacement systems in use today. The results obtained for the displacement portion of this study are questionable for the following reasons:

1. The data was obtained from a system operating with -0.1" H_2O vacuum assist, and thus cannot be related to displacement systems in use today.

2. The amount of vapor actually displaced was estimated but not measured.

Calgon Report - July 10, 1974

The purpose of their tests was to determine the vapors emitted from vehicle fueling operations during summer conditions with a low RVP (8.2 psi) fuel. Results of the study indicate a 5% vapor growth at zero ΔT can be expected. Regression line for the system was:

$$V/L = -0.008\Delta T + 1.050$$

Only "no leak" or baseline cars were used as data points for the regression curve. A tight seal between the nozzle and fill neck was accomplished by cementing a rubber bushing to the inside of the fill neck which would make a tight fit with the vapor return nozzle.

Testing was conducted at a small fleet fueling center in San Diego. The test procedures used appeared valid except for the fact that the dispensed fuel temperature was measured in the underground tank instead of at the nozzle. Other data indicated that the temperature of the dispensed fuel may have been several degrees warmer than the underground tank temperature when it reached the nozzle, especially when the nozzle was exposed to direct sunlight on a hot summer day. Both the volume and hydrocarbon content of the displaced vapors were measured; however, hydrocarbon content was not reported.

Olson Laboratory Report - October, 1973

The objective of this study was to determine the technical and economic feasibility of using a carbon canister system on automobiles to control refueling vapor losses. The study concluded that a large carbon canister could effectively control vapor losses resulting from vehicle refueling. It should be noted, however, that before this system can work properly, a tight seal at the nozzle-fill neck interface is necessary.

Scott Laboratories Report - September 1, 1972

This report presents the results of a combination field and laboratory study to determine the amount of hydrocarbon losses which occur upon vehicle refueling with no emission controls. The study indicated that the amount of noncontrolled hydrocarbon emissions were 5.3 grams per gallon of fuel dispensed. Of that amount 5 gm/gal were attributed to displaced vapor losses and 0.3 gm/gal were attributed to gasoline spillage.

A regression line was developed which can be used predict the amount of uncontrolled hydrocarbon emissions from vehicle refueling. The equation is:

$$L_D = \exp\,(a + b \cdot T_{DF} + C \cdot T_V + d \cdot T_V \cdot RVP)$$

where

L_D = Estimate of displaced loss (gm/gallon)

T_{DF} = Average dispensed fuel temperature (^{o}F)

T_V = Average displaced vapor temperature (^{o}F)

RVP = Reid Vapor Pressure (PSI)

$a = -0.02645$

b = 0.01155

c = -0.01226

d = 0.00246

The spillage loss was determined from data provided by 7,151 field observations of refueling operations. The report states that the effect of the presence of the observers, if any, is unknown; and, therefore, the results obtained may reflect spill losses closer to a minimum than an average.

Refueling losses were evaluated from experimental data obtained from filling automobile gasoline tanks contained in a mini-SHED (acronym for Sealed Housing for Evaporative Determinations). The results obtained from this study have been questioned due to the fact that the dispensed gasoline was reused over a period of several days and had shown signs of weathering.

Attempts were made during this study to determine the amount of displaced hydrocarbon emissions attributable to entrained gasoline droplets. The determination was to be made by quantitatively measuring losses from both top filling and bottom filling operations. A statistically significant difference in losses was noted; however, the difference cannot all be attributed to entrained droplets since bottom filling operations preclude the inclusion of excess fuel vaporization which may result from top filling. This issue was not resolved during the course of this study as it was outside the scope of Scott's work. It is, however, an issue that should definitely be resolved in some future study.

Standard Oil of California Report - November 27, 1973

This report presents the results of a study to determine the hydrocarbon vapor recovery effectiveness of a displacement system conducted by Standard Oil of California in September and November, 1973. Data obtained from field monitoring of 113 vehicle refuelings and 18 underground tank refills were used in preparing this report. Results indicated that a vapor recovery efficiency of 95.6% could be expected from underground tank refills and an efficiency of greater than 85% was achievable during vehicle refueling. There were no losses from the underground tank vent.

The experimental procedure used was essentially the same as that used during EPA tests except that analyses for the hydrocarbon concentration of returned vapors were not made. Results were, however, evaluated on the basis of hydrocarbon recovery after the following assumptions were made:

1. The returned vapors are saturated with hydrocarbon at the temperature of the returned vapor.

2. The total possible amount of hydrocarbon to be collected is 80% of the Cape 9 Study.

These baseline curves were developed in this study. Curve 1 results from data obtained in September and Curves 2 and 3 result from data obtained in November. Equations for the curves are:

Curve 1: $V/L = 1.07 - 0.018\Delta T$

Curve 2: $V/L = 0.86 - 0.0157\Delta T$

Curve 3: $V/L = 0.93 - 0.0114\Delta T$

Reasons for differences in the curves are not readily apparent. The dispensed fuel RVP was 8.5 psi for all tests. The ambient temperature was 20°F cooler in November than September. Dispensed gasoline temperatures reflected the change in ambient temperatures in this data.

Results of tests demonstrating other vehicle refueling emissions were also presented. Tests of vehicles with and without evaporative emission controls showed that approximately 5.6% of the total displaced hydrocarbons were emitted out the vents of vehicles containing no emission controls. Data was also presented which indicated that less than 2% of the total vapor emitted from a vehicle would pass forward to the carbon canister.

Atlantic Richfield Report - April 8, 1974

This report presents the results of a study to determine the performance of a vapor balance system. Testing was conducted by Atlantic Richfield Company at a service station in Diamond Bar, California, from March 5-12, 1974. Tests showed their vapor balance system to have an overall vapor recovery efficiency of greater than 88% with a vapor recovery efficiency of greater than 99% for the underground tank filling operation. These results were based on data obtained from 137 vehicle refuelings and only one underground tank refill. ARCO stated in their report that previous testing of underground tank refills indicated a vapor recovery efficiency of 95% is more typical for that operation.

ARCO used a material balance approach in their test program. Oxygen content of returned vapors was measured. This data was used to calculate the amount of displaced hydrocarbons. Preweighed carbon canisters were placed on the vehicle vent lines to measure the amount of hydrocarbon absorbed. Results of this measurement showed that 0.087 gm hydrocarbon were absorbed for each gallon dispensed. This accounts for approximately 2% of vapors displaced.

The baseline used for calculation by ARCO differs from that required by EPA in that the underground tank temperature was used by ARCO in calculating ΔT's instead of the dispensed gasoline temperatures. Test data taken by others indicate that dispensed gasoline temperatures may vary by several degrees from the underground tank temperature. The regression curve derived from the ARCO data is:

$$V/L = 0.9 - 0.012\Delta T$$

Exxon Report - May 31, 1974

This report presents the results of a detailed study of hydrocarbon emission controls at service stations. The study and testing undertaken by Exxon were predominately concerned with various aspects of vapor balance systems; however, some testing of a vacuum-assist system was also performed.

Their determinations of vapor recovery efficiencies during vehicle refueling were based upon a comparison of the actual measured amount of returned vapors with the amount predicted by a theoretical regression line. The equation of the line, as derived by EXXON, is:

$$V/L = 1.00 - 0.013\Delta T$$

These tests showed an average vapor recovery of 81% was achievable with existing technology.

Exxon reported the results of numerous tests on underground tank refills. The average vapor recovery efficiency for these fuel drops was reported to be 97%. Additional results reported for the balance system indicate there are essentially no losses attributable to underground tank breathing. It was also reported that an average of only 2% of all displaced vapors is lost through vehicle vents.

Vacuum assist testing involved only evaluation of the vapor recovery nozzle portion of these systems. It was demonstrated that an explosive mixture could be created in the vehicle fuel tank by using this type nozzle. For this situation to occur, however, conditions would have to be extreme; the dispensing nozzle must continue to draw in air after product flow has been stopped. Data was also presented which showed that a positive pressure was maintained in the vehicle tank while liquid was being dispensed with as much as 17" H_2O vacuum at the nozzle-fill neck interface.

Scott Report - June 26, 1974

Three vapor recovery systems (direct displacement, carbon canister, and refrigeration) were tested by Scott Laboratories to determine their vapor recovery efficiency. Data was obtained on 97 underground tank refills and 292 vehicle refuelings. All vehicle refueling data was obtained only on vehicles employing emission control systems (carbon canisters) and upon which a "tight fit" or "no leak" seal could be maintained at the vehicle-fill neck interface.

Of the 97 tests on underground tank vapor recovery efficiencies, six were conducted on a refrigeration-condensation system and four were conducted on a carbon absorption system. The average control efficiency for these ten tests was 99.99+%.

The remaining 87 underground tank filling tests were conducted at direct displacement systems. The average recovery of these tests was 96.49%. The displacement tests were further broken down into three categories:

1. systems employing an open 2" vent,
2. systems employing a restrictive orifice, and
3. systems employing a P-V valve.

Results of this breakdown indicated the following:

1. The average recovery efficiency for an open 2" vent was 92.24%.
2. The average recovery efficiency for a restrictive orifice was 96.90%.
3. The average recovery efficiency for a P-V valve was 99.03%.

The vapor displaced from individual vehicles was not measured during these tests as only the vehicles whose nozzle-fill neck interface showed a zero leak were used. Measurements of the amount of vapors emitted from the system were taken only at the vent of the underground tank.

Only five vehicle refueling tests were performed on the refrigeration system due to equipment malfunctions. Data from these limited tests did indicate, however, that the system would produce little or no hydrocarbon emissions when operating properly.

The remaining tests of the displacement system were performed either on an open system or one employing a P-V valve. It was shown that the restrictive orifice does nothing to control emissions from vehicle refueling and that such systems behave essentially the same as those with open vents. Tests showed that the systems with the P-V valve allowed little or no emissions, and that a simple direct displacement system with an open vent would control approximately 96% of the hydrocarbon emissions.

It must be remembered that the data in this study was obtained only from vehicles employing evaporative emission controls, and then only on vehicles producing a "tight" or "no leak" seal at the nozzle-fill neck interface. While these two conditions certainly are not the "norm" today, it is highly plausible that they will become the "norm" in a couple of years. These data are useful, at any event, as a demonstration of the degree of control achievable with a "tight-fit" connection at the nozzle-fill neck interface.

TRW Report - August, 1974

This report presents the results of three weeks of field testing performed in June, 1974, to evaluate the vapor recovery efficiency of five vapor recovery systems. Two of the systems evaluated were displacement type systems and three were vacuum assist type systems.

A material balance approach was used in the test procedure. All necessary parameters were monitored to permit calculations of percent recovery and the mass amount of hydrocarbon emissions (gm/gal). Results were reported on a percent recovery basis.

Only one baseline curve was generated for both displacement systems tested, and it was used to calculate recovery efficiencies for both systems tested. The equation as developed by TRW for the baseline is:

$$V/L = 0.91 - 0.0155\Delta T$$

Hydrocarbon recovery efficiencies are reported to be from 65 to 85 percent for the two systems tested. The main source of vapor loss was leakage at the nozzle-fill neck interface.

Only one of the three vacuum assist systems tested was found to be operating properly. Testing showed that a properly operating secondary system can achieve over 90% hydrocarbon recovery efficiency. These tests also illustrated, however, that secondary systems available today are subject to many hours of downtime due to operational problems and hence will have great difficulty in achieving 90% hydrocarbon control.

Data was also taken during these tests to determine the hydrocarbon recovery efficiency of each system for underground tank refills. Results indicated that a recovery efficiency of 99+% was achievable on bulk drops when using a secondary recovery system. Results on the two displacement systems indicated recovery efficiencies of greater than 96% can be attained.

Summary of Results by Others

Although the final recovery efficiencies varied from report to report, the results do illustrate the level of hydrocarbon recovery efficiency attainable today by several different methods. All reported results on underground tank refilling indicate that recovery efficiencies of approximately 96% are achievable today by employing the displacement system only. There is significant data on secondary recovery systems for bulk drops indicating a 99% vapor recovery is achievable when equipment is operating properly. Since the secondary equipment generally processes only the excess vapors, a nonoperative secondary system can still be approximately 96% efficient.

All reported results on vapor recovery efficiencies of properly designed displacement systems for vehicle refueling (except the 19 April 1973 Calgon Report) indicate that a vapor recovery efficiency of greater than 80% is attainable with equipment available today. One of the systems tested by TRW exhibited a vapor recovery efficiency somewhat less than 80%, but the system piping was originally installed for a vacuum assist unit and was modified for displacement. The losses experienced by these systems occurred predominately at the nozzle-fill neck interface for each case.

Results provided in the June, 1974 Scott Report indicate that recovery efficiencies of 95% are attainable with displacement systems which have no leaks at the nozzle-fill neck interface. It is evident that the effectiveness of displacement systems are heavily dependent upon achieving a tight fit at the nozzle-fill neck interface.

Results were presented in three reports giving vapor recovery efficiencies for vacuum assist units. All reports stated that the secondary processing units were capable of vapor recovery efficiencies well over 90%. These claims are reasonable. Hydrocarbon vapor recovery equipment has been in use for many years, and the technology of such is well established.

These reports also cited cases where some of the units could not be tested at times due to equipment malfunctions. Since these units can only process vapors when the equipment is in proper working order, the expected working time, or "stream factor" must be considered in evaluating the overall recovery efficiency of this type unit.

Another potential source of hydrocarbon loss from vacuum assist systems is the nozzle-fill neck interface. Data taken by TRW indicates that over 20% of the vehicles refueled exhibited positive explosimeter readings. The positive readings may have been caused by leakage of gasoline, but they also may have been caused by hydrocarbon vapor losses. Should the readings have been caused by escaping vapor, the amount lost is presently not determinable. Methods should be developed to quantify these possible leaks.

4.0 SERVICE STATION SOURCE TEST REPORT

Source testing has been performed at two service stations employing vapor displacement recovery systems. Discussion of the test procedures and analysis of results of these tests are included in this section.

4.1 Introduction

Source testing of displacement vapor recovery systems installed at service stations was conducted from July 29 through August 16, 1974. Testing was performed at two service stations: one was located in Hayward, California and the other in Davis, California. Schematics of each vapor recovery system are included as Figures 4.1-1 and 4.1-2 The actual testing was conducted by a source testing team from Betz Environmental Engineers. The major variables measured are listed for each vehicle tested on the attached data sheets. No outbreathing from the underground tank vent lines was recorded during these tests. Radian had personnel at the test sites throughout the duration of the tests, and EPA had personnel present during the first 1½ weeks.

The test objectives were to gather data on vapor balance system performance under several conditions. Both mass emissions (gm/gal) and recovery efficiency were to be evaluated from this data. Vapor balance modifications that were to be evaluated from these tests are:

- the effect of manifolding vapor return lines on hydrocarbon recovery,
- the effect of a pressure-vacuum valve on hydrocarbon recovery, and

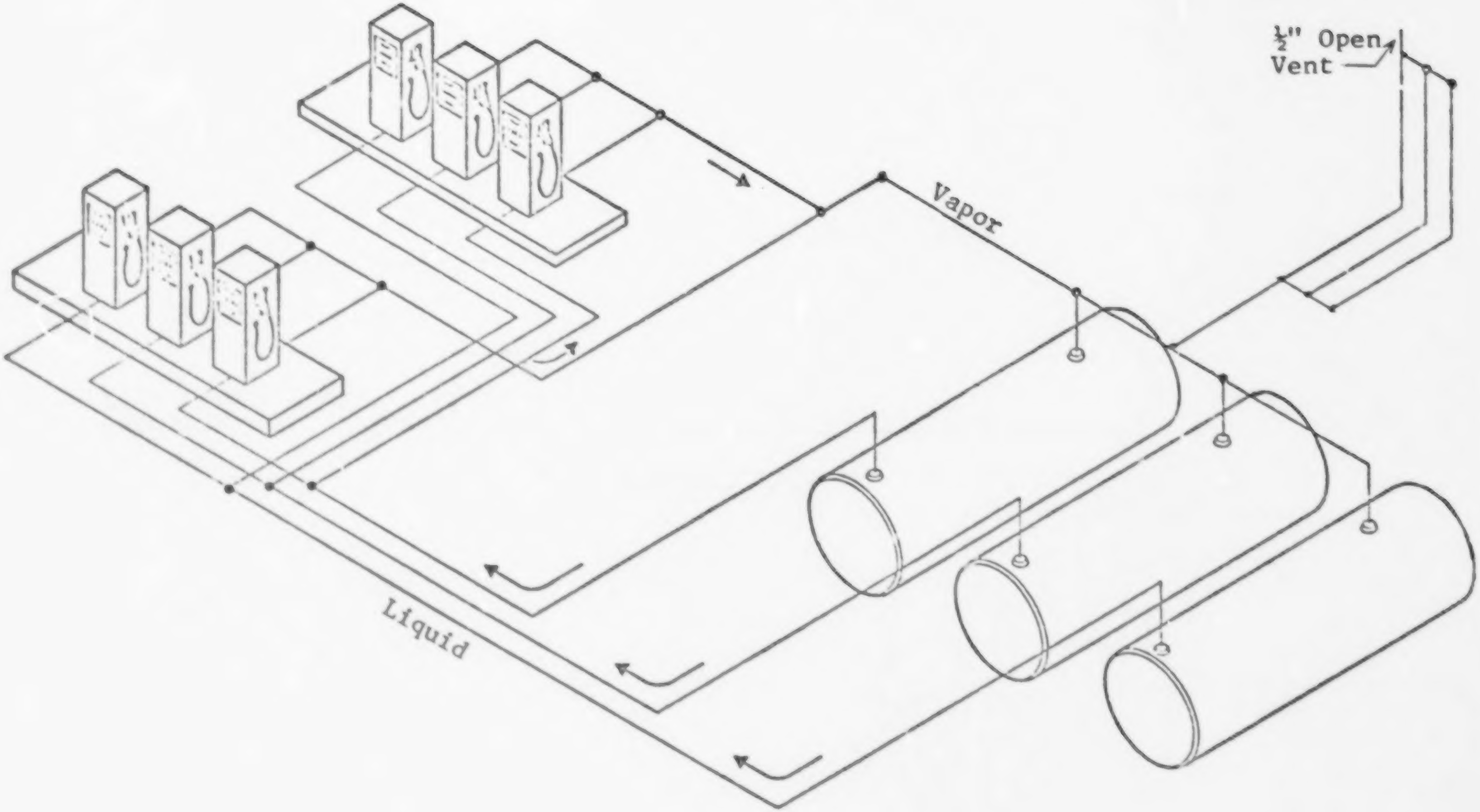
½" Open
Vent
Vapor
Liquid

FIGURE 4.1-1 - TYPE I VAPOR BALANCE SYSTEM

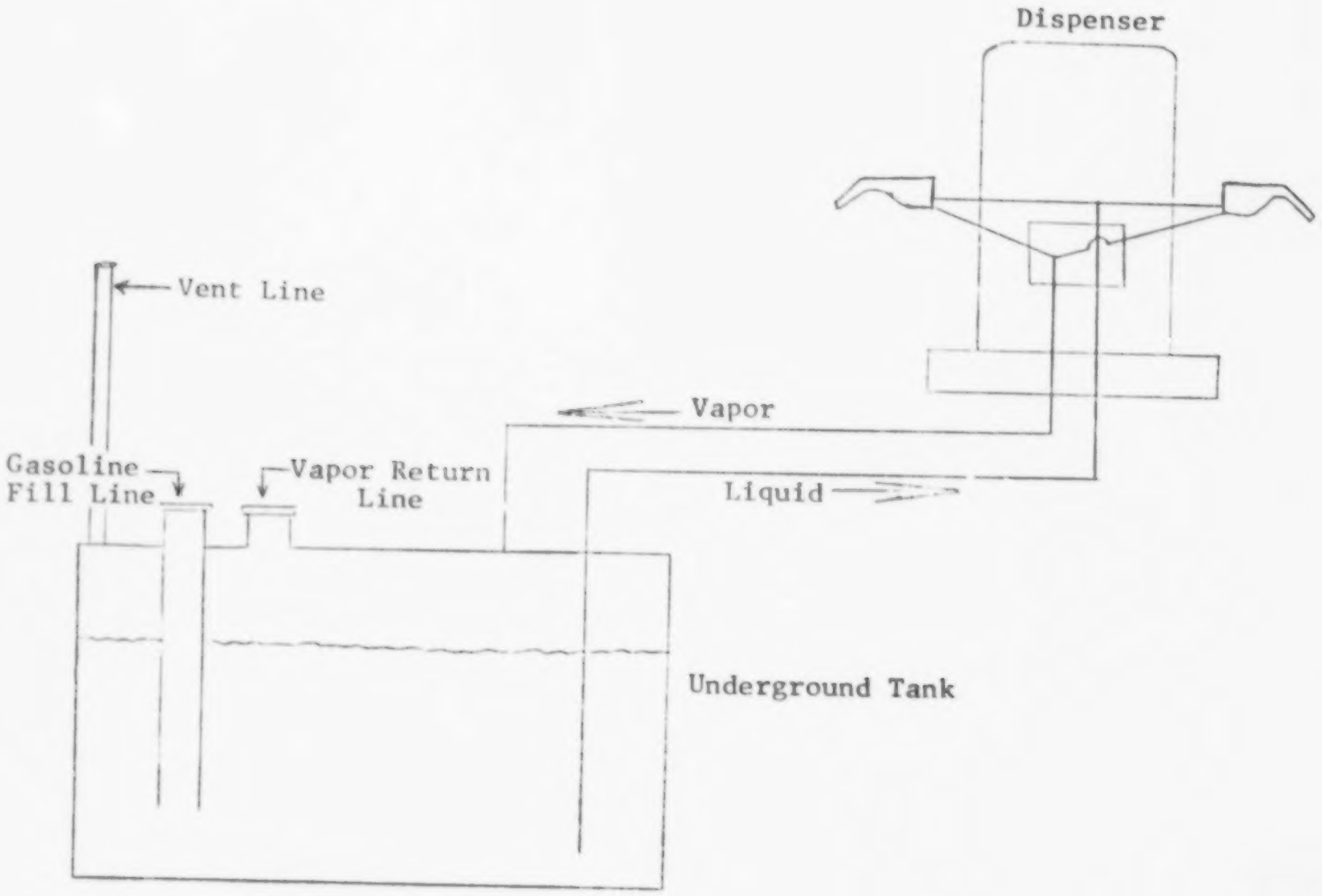
Dispenser
Vent Line
Vapor
Gasoline Fill Line
Vapor Return Line
Liquid
Underground Tank

FIGURE 4.1-2 - TYPE II VAPOR BALANCE SYSTEM

- the effect of different nozzle designs on vapor recovery.

Over 700 vehicles were tested over this three week period. The breakdown of vehicles by test type is:

Regular Fills	424	(58.5%)
Baseline	128	(17.6%)
Baseline Attempts	142	(19.6%)
Bad Data	31	(4.3%)
Total Vehicles	725	

4.2 Service Station Selection

Two service stations were selected for testing in an attempt to evaluate the effects of differences in system design. Station I employed a manifolded vapor recovery system and Station II had individual vapor return lines for each grade of gasoline.

The station locations were selected in an attempt to provide the greatest temperature differentials. Station I was located in Hayward, California which is near San Francisco Bay. Ambient temperatures during testing ranged from the low 50's to the high 70's. Temperatures experienced at Station II located in Davis, California, varied from near 60°F to over 100°F.

4.3 Chronology of Testing Events

4.3.1 Station I

The test crew arrived at the site early on the morning of July 29, and spent that day preparing and setting up equipment. The equipment setup continued for a portion of the following day, July 30, with field testing beginning around 11:00 a.m.

The testing schedule for the remainder of the week was as follows:

July 31	0800 - 1600
Aug. 1	1200 - 2000
Aug. 2	0800 - 1200

During the first week of testing, data was obtained on 235 vehicles. Of these, between 50 and 60 cars were classified as baseline. There were no fillings of the underground tanks during the test period.

Baseline data was defined as that obtained from automobiles which met the following criteria: (1) there could be no leak at the nozzle-fill neck interface as indicated by a 0% explosimeter reading, (2) the fuel tank must hold a positive pressure of 3" H_2O. The carbon canisters or vent lines were blocked on baseline attempts.

4.3.2 Station II

Testing of this station was started August 5. Only about half a day was used for equipment setup for this station. Testing objectives were to evaluate the collection efficiency of two different vapor recovery nozzles in addition to evaluating the service station's overall vapor recovery efficiency. Measuring the effects of a pressure-vacuum valve were also planned for this station. The testing schedule for the week of August 5 was as follows:

Aug. 5	0800 - 1700
Aug. 6	0700 - 1500
Aug. 7	1100 - 1900
Aug. 8	0800 - 1600
Aug. 9	0700 - 1200

The schedule for testing was staggered in an attempt to obtain test data under a variety of temperature conditions.

The two types of nozzles used during testing at Station II were very similar in appearance as each employed rubber boots to effect a seal at the nozzle-fill neck interface. The major difference in the nozzles was the design of their check valves. Nozzle Type I employed a mechanical check valve which would open only when it was forced onto the lip of a vehicle fill neck, and nozzle Type II employed a "flapper" valve in the nozzle's vapor return line which would open under a very small pressure gradient.

The comparative nozzle efficiency evaluation was discontinued after the third day due to inbreathing problems experienced by one of the nozzles (Type II). Several times throughout the test period this nozzle was observed inbreathing air while not in use. This phenomena appeared to occur only when the other nozzle (Type I) pumped a large volume of gas, say greater than 15 gallons. As both vapor return lines were manifolded together very close to the gasoline dispenser, it is believed that the inbreathing resulted from a negative pressure in the vapor return line caused by pumping a relatively large volume of gasoline from the underground tank. The effect of inbreathing was to lower the vapor recovery efficiency of the system. The results from these days cannot be used to compare the system efficiency of Station I and Station II.

The Type II nozzle was used alone on Thursday, August 8. On Friday, August 9, vehicle refueling was conducted using two of the Type I nozzles, which were retained for the duration of testing. This type nozzle was utilized in testing Station I also.

Underground tank refilling was performed on Friday August 9 due to low gasoline avails. Only 4350 gallons were dropped to insure that adequate room would be left for a drop the following week while evaluating the effects of a pressure-vacuum valve. Both types of nozzles were still in place during this tank refueling. The nozzles were sealed with plastic bags in an attempt to prohibit vapor leaks.

Testing of vehicles resumed the morning of August 12 and continued through August 14. On August 15 and 16, the system was tested with a pressure-vacuum valve on the underground vent line.

During the weekend, an unexpected tank drop was made. The dry gas meter showed that no outbreathing occurred during this drop. Unfortunately, the meter measuring inbreathing was not read before vechicle refueling was started the morning of August 12; consequently, the amount of inbreathed air was not determined.

The test schedule for the week of August 12 was as follows:

Aug. 12	0800 - 1500
Aug. 13	0700 - 1500
Aug. 14	1200 - 1900
Aug. 15	1000 - 1800
Aug. 16	0800 - 1200

As before, the test schedule was staggered in an attempt to obtain data under a variety of temperature conditions.

Early in the week, two different types of pressure-vacuum valves were bench tested. Figures 4.3-1 and 4.3-2 are schematics of the valves. The pressure and vacuum settings were preset on the Type A valve by selection of the density of the balls used to seal the valve openings. The settings of the Type B valve were varied by adjusting the tensions of the springs inside the valve.

The Type A valve opened at -4" H_2O and at +0.8" H_2O. The Type B valve was set to open at the same pressure. The bench scale tests showed that the settings on the Type B valve varied slightly when subjected to repeated pressure and vacuum surges. This was attributed to wear on the sealing gaskets. The Type A valve showed little or no variance in the pressures at which it opened when subjected to the same tests. Consequently, the Type A valve was selected for use on the system for the tests evaluating recovery efficiencies using a pressure-vacuum valve.

Testing proceeded smoothly during the week. Early in the week, however, one of the thermocouples measuring dispensed gasoline temperature malfunctioned. These thermocouples were not field calibrated.

The system was modified on August 15, to include the pressure-vacuum vent on the underground tank. Vehicle refueling was conducted for a two hour period prior to a tank drop and the underground tank pressure remained at about atmospheric pressure. During the drop, the tank pressure dropped to about -7" H_2O but quickly rose to -.15" H_2O at the drop's termination. The pressure remained at that value through the vehicle refueling testing.

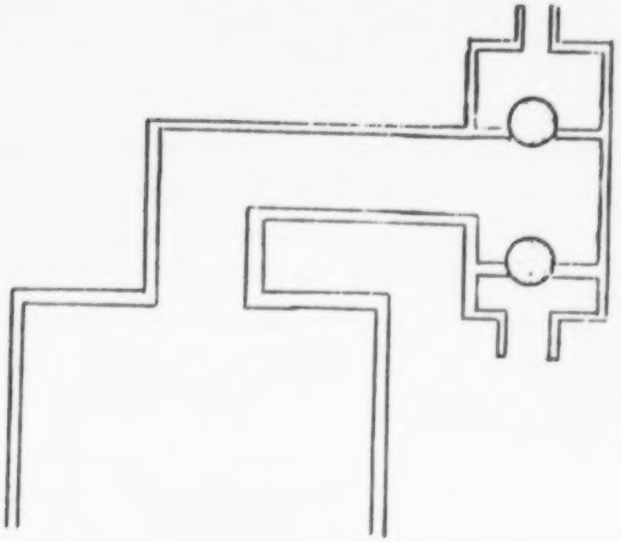

FIGURE 4.3-1 - SCHEMATIC OF TYPE A
PRESSURE-VACUUM VALVE

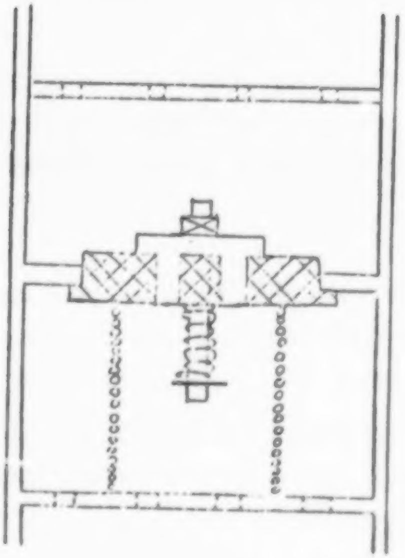

FIGURE 4.3-2 - SCHEMATIC OF TYPE B
PRESSURE-VACUUM VALVE

4.4 Test Results

4.4.1 Summary of Efficiencies

Vapor recovery efficiencies were determined for each of the systems tested. Table 4.4-1 is a summary of those results.

These results were obtained only after an engineering analysis of the raw data. It was evident after a preliminary look at the assembled test data that major discrepancies existed in the recorded dispensed gasoline temperature values. Each nozzle being monitored dispensed gasoline from the same underground tank. Therefore, the dispensed gasoline temperatures should have been about the same for all nozzles. Differences as great as 20°F were recorded, however. Dispensed gasoline temperatures were subsequently plotted for each day of testing and are shown in Figures 4.4-1, 4.4-2, and 4.4-3.

The effect of inaccurate dispensed gas temperature data can be critical since the temperature differential between the vehicle tank and the dispensed gasoline is fundamental in the calculation of system efficiency. The following example illustrates this point. The recorded test data were as follows:

Vehicle Tank Temperature	95°F
Dispensed Gas Temperature	95°F
Volume Returned Vapor	0.65 ft^3

The ΔT for these values is zero. The baseline curve from Station II would have predicted a volume of returned vapor to be 0.973 ft^3 at a zero ΔT, assuming 7.48 gallons dispensed. For the above test data, recovery efficiency is calculated to be only 67%. For a dispensed gasoline temperature of 75°F, the ΔT becomes

TABLE 4.4-1

SUMMARY OF VAPOR RECOVERY EFFICIENCIES FOR TESTING PERFORMED 7/30/74 - 8/16/74

Test Condition		Vapor Recovery %
Station I		
7/30 - 8/2	Overall recovery with Type I nozzle	69.6
Station II		
8/5 - 8/8	Overall recovery with Type I and Type II nozzles	75.5
8/5 - 8/8	Recovery with Type II nozzle only	78.9
8/5 - 8/7	Recovery with Type I nozzle	71.8
8/9 - 8/14	Overall recovery with Type I nozzle	83.5
8/15 - 8/16	Recovery with P-V valve	78.2

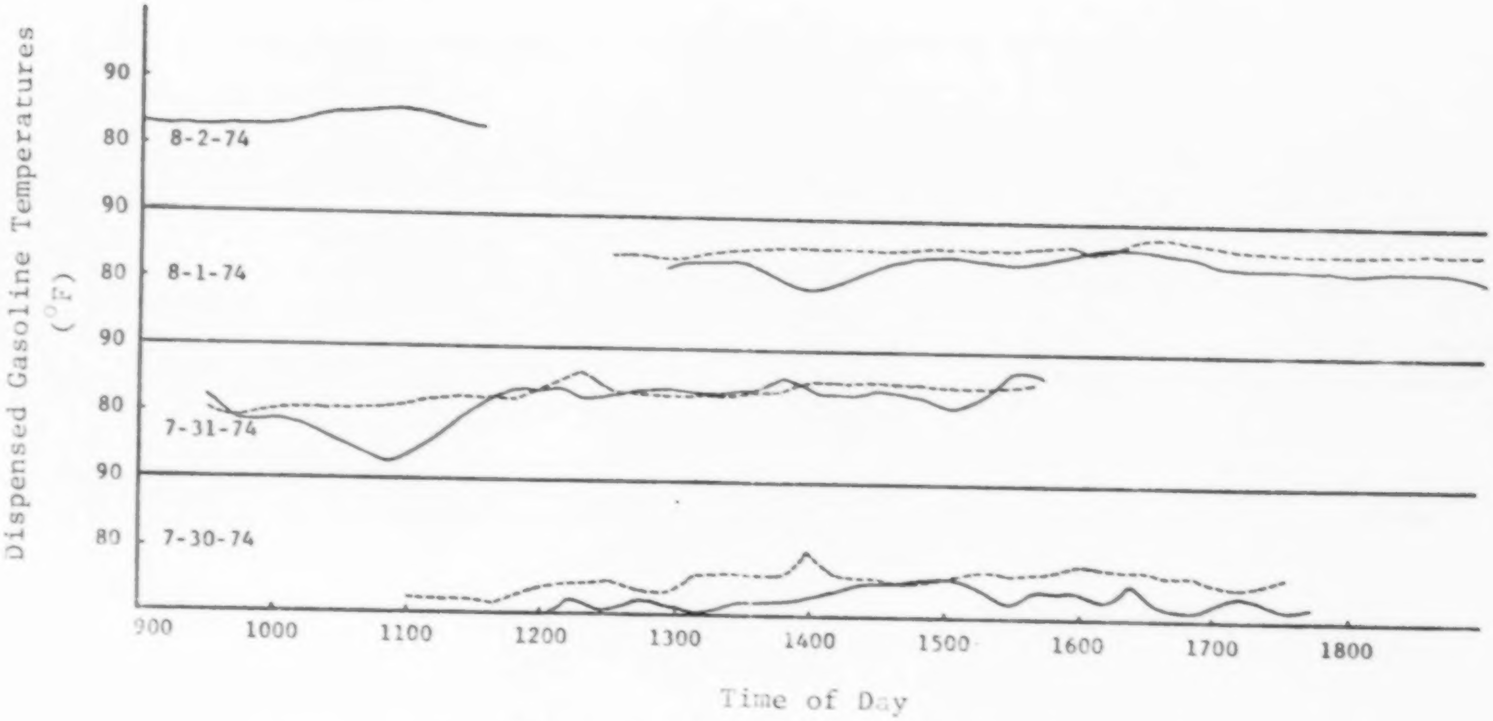

FIGURE 4.4-1 - COMPARISON OF DISPENSED GASOLINE TEMPERATURES

___ Nozzle A
--- Nozzle B

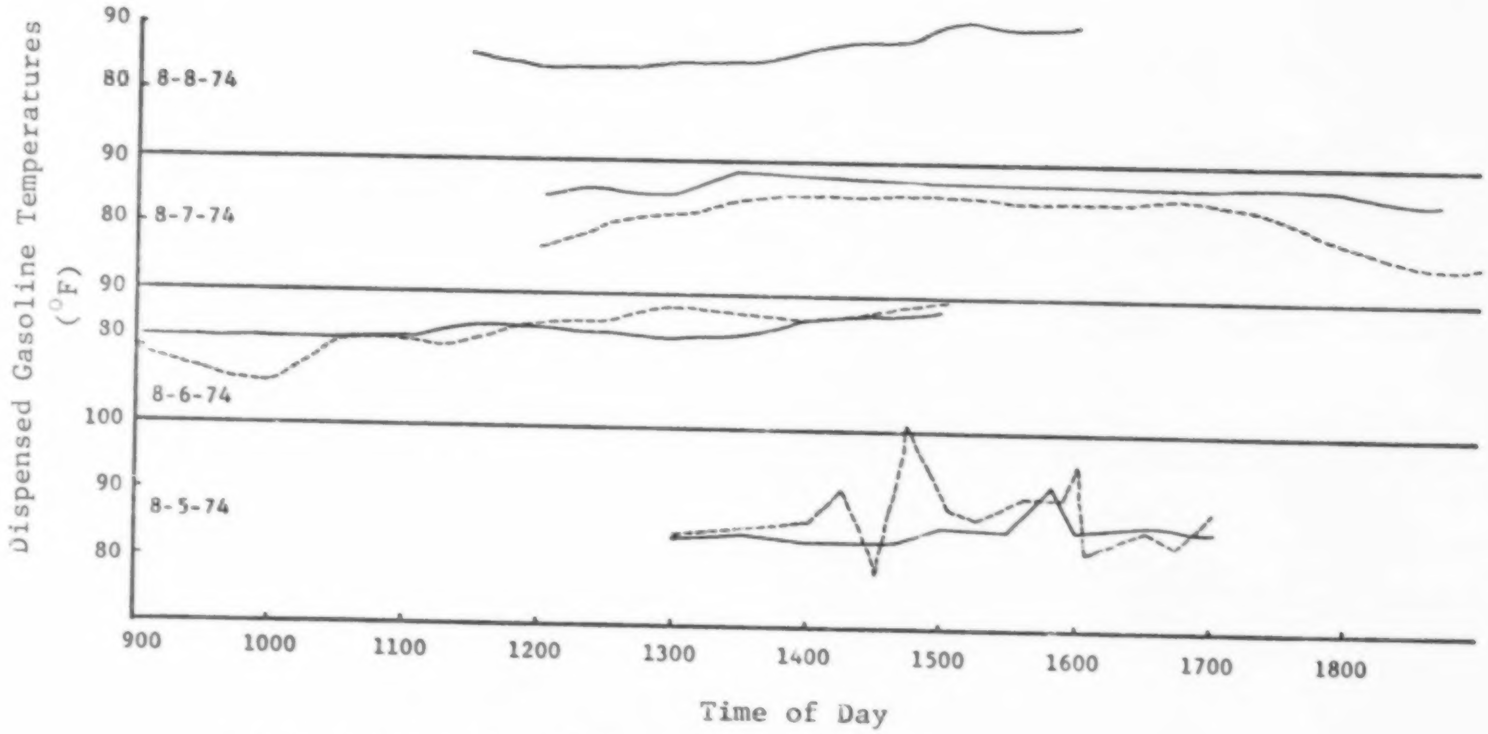

FIGURE 4.4-2 - COMPARISON OF DISPENSED GASOLINE TEMPERATURES

—— Nozzle A
--- Nozzle B

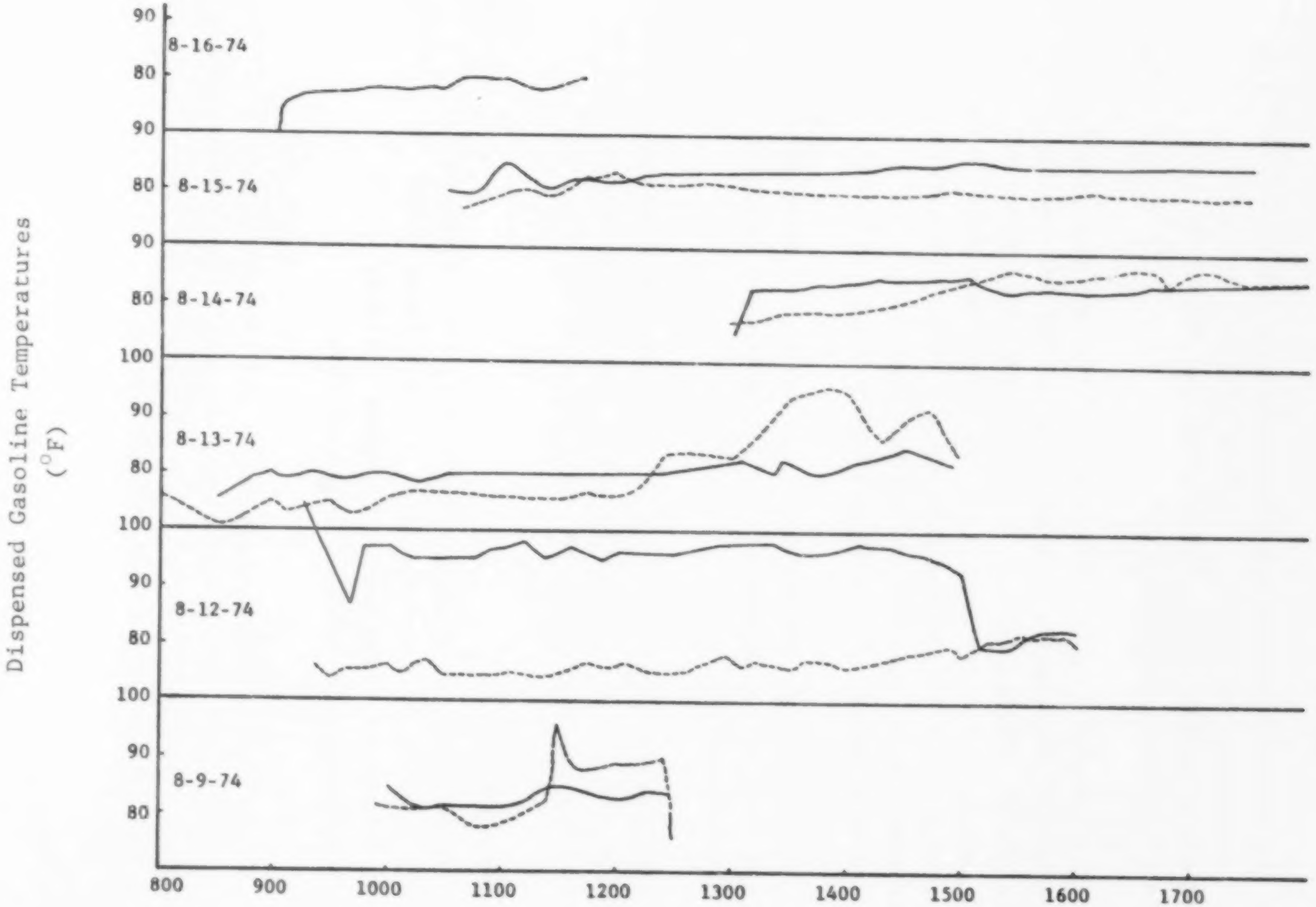

FIGURE 4.4-3 - COMPARISON OF DISPENSED GASOLINE TEMPERATURES

___ Nozzle A
--- Nozzle B

$+20^\circ$, and the baseline prediction of returned vapors is 0.653 ft^3. This would correspond to a vapor recovery efficiency of 99%+. Again, the above example is to demonstrate the effect of ΔT on calculated recovery efficiency.

Figures 4.4-1, 4.4-2 and 4.4-3 illustrate the discrepancies in the dispensed gas temperatures recorded during the source tests. Corrections to data for the temperature of dispensed gasoline from one nozzle or the other were made to be consistent with recorded temperatures of the other nozzles in use at the same time. Vehicles on which these changes were made are appropriately marked on the data summary sheets attached.

These results indicate that Station II was more efficient than Station I. Reasons for this conclusion have not yet been determined.

The results also indicate that the pressure-vacuum valve used on Station II was ineffective. Data taken on the underground tank pressure confirms this.

4.4.2 Baseline Curves

Least square fits were performed on all baseline vehicles for each case listed in Table 4.4-1. Table 4.4-2 provides a summary of these baseline curves. Figure 4.4-4 diagrammatically compares each of these curves.

It can be seen from these plots that the baseline data taken under a variety of conditions are quite consistent. This would indicate that the amount of vapors displaced are independent of the design of the displacement system.

TABLE 4.4-2

SUMMARY OF BASELINE CURVES FOR TESTING PERFORMED 7/30/74 - 8/16/74

Test Condition		Baseline Equation*
Station I		
7/30 - 8/2	Type I nozzle	$V/L = 1.022-0.015\Delta T$
Station II		
8/5 - 8/8	Both nozzle types	$V/L = 0.947-0.017\Delta T$
8/5 - 8/8	Type II nozzle	$V/L = 0.906-0.014\Delta T$
8/5 - 8/7	Type I nozzle	$V/L = 1.023-0.023\Delta T$
8/9 - 8/14	Type I nozzle	$V/L = 0.973-0.016\Delta T$
8/15 - 8/16	P-V valve	$V/L = 0.926-0.017\Delta T$

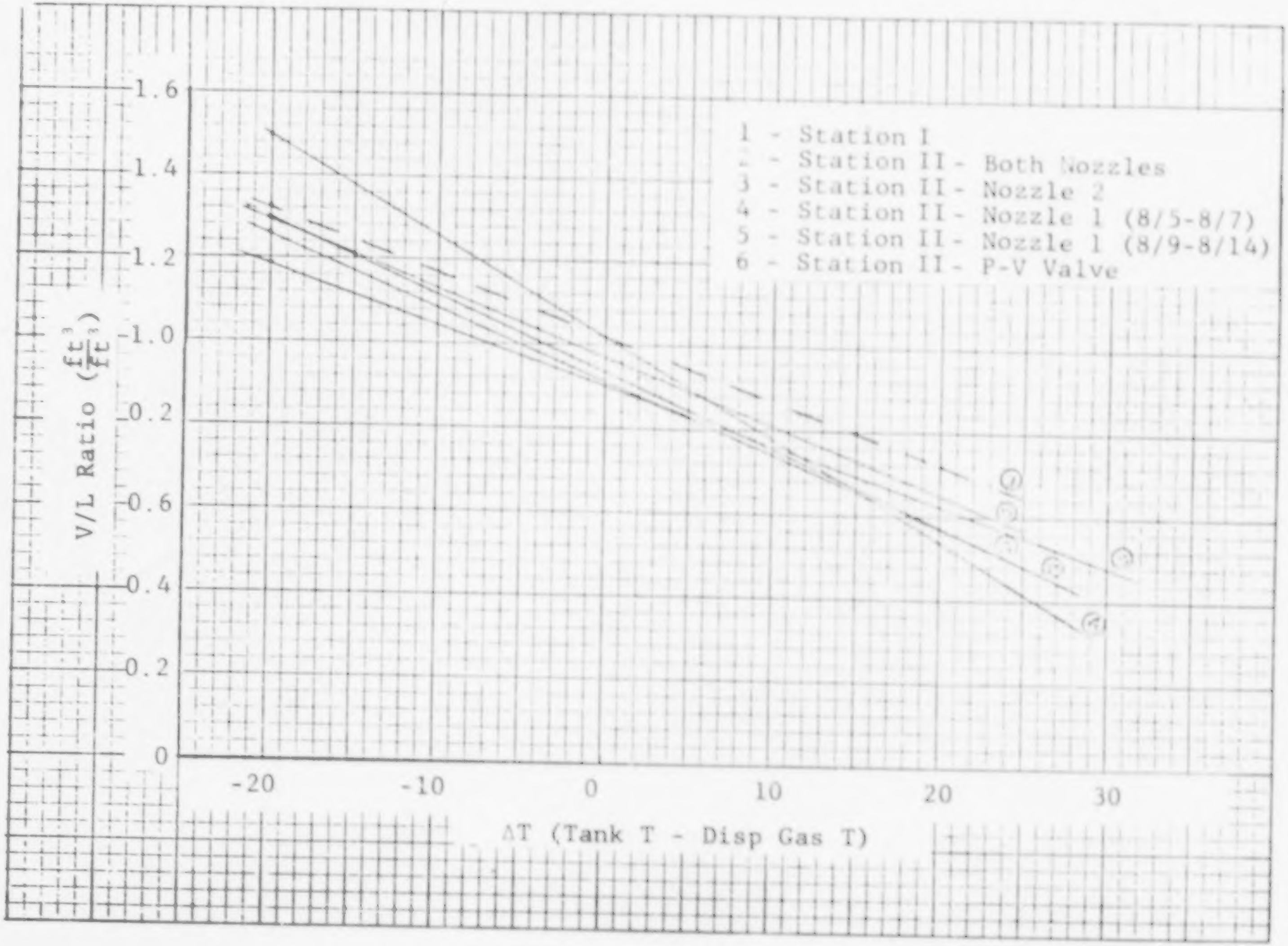

FIGURE 4.4-4 - BASELINE CURVES FROM TESTS PERFORMED 7/30/74 - 8/16/74

4.4.3 Mass Emissions

The test plan was designed to obtain data to permit calculations of mass emissions (grams per gallon dispensed). After the completion of the tests it was discovered by the test crew that the monitors measuring hydrocarbon content in vapor displaced from vehicle tanks were not working properly. Consequently, these measured hydrocarbon values were not usable.

Mass emissions were subsequently calculated, however, by assuming the displaced vapors were saturated with hydrocarbons at their measured temperature in the vapor return line. The RVP of the dispensed gasoline at both service stations was 8.5 psi. This RVP was used for the calculations.

The assumption was checked with data taken by TRW in San Diego in June, 1974. Plots were made comparing the measured hydrocarbon concentration of the returned vapors to the calculated saturated vapors of the dispensed gasoline. The plots, shown in Figures 4.4-5 and 4.4-6, would indicate the assumption to be valid. A plot of the calculated hydrocarbon concentrations versus returned vapor temperature for the test vehicles is provided as Figure 4.4-7.

Tabular results of the mass emission calculations are provided in Table 4.4-3. It is emphasized that these emissions were made without the benefit of actual hydrocarbon concentration measurements, and are estimates only.

4.4.4 Underground Tank Drops

Measurements were made on underground tank refillings which occurred on August 9, and August 15. Essentially no outbreathing was recorded during these drops and the recovery

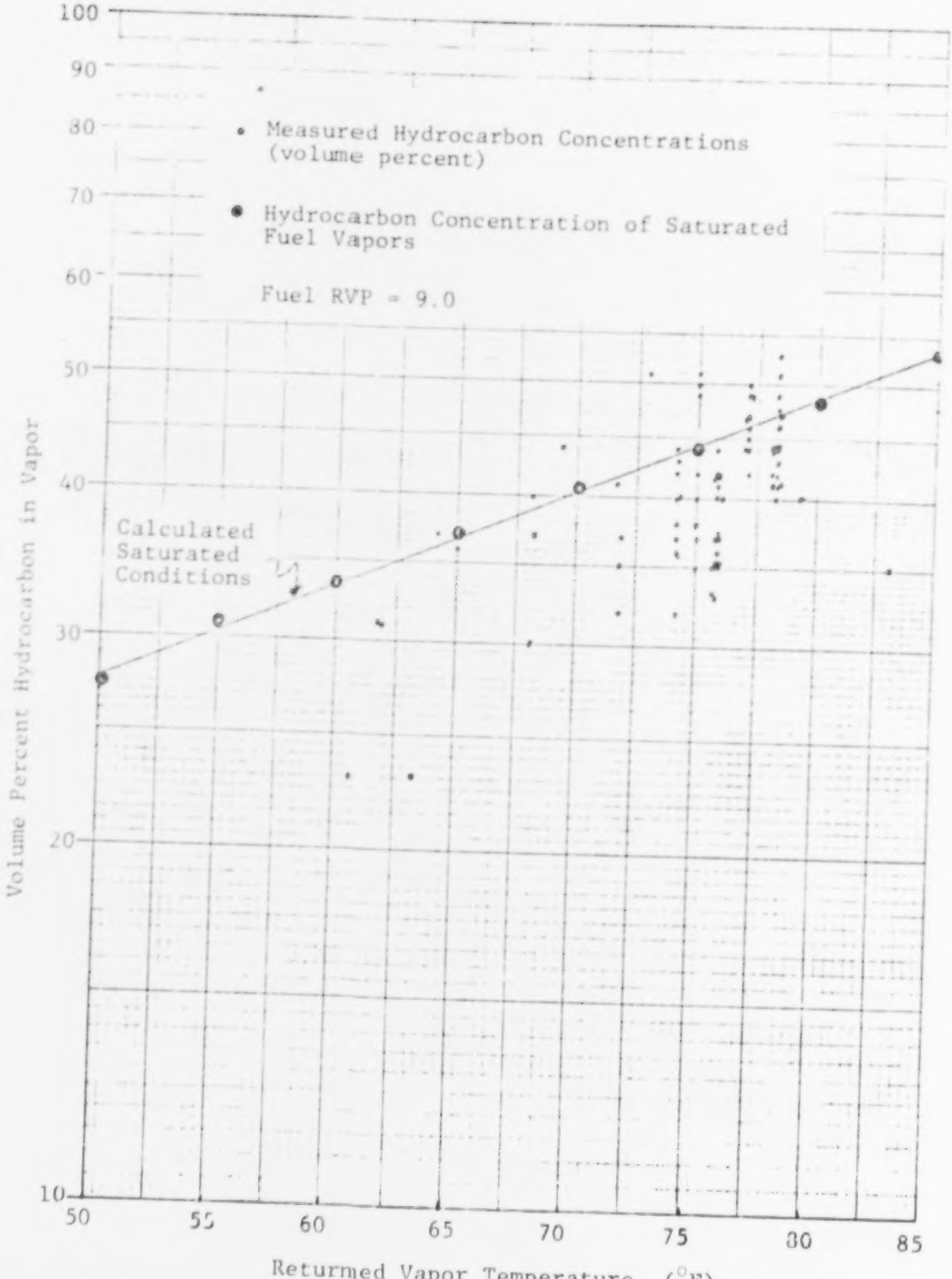

FIGURE 4.4-5 - COMPARISON OF MEASURED HYDROCARBON CONCENTRATIONS AGAINST HYDROCARBON CONCENTRATIONS OF SATURATED FUEL VAPORS

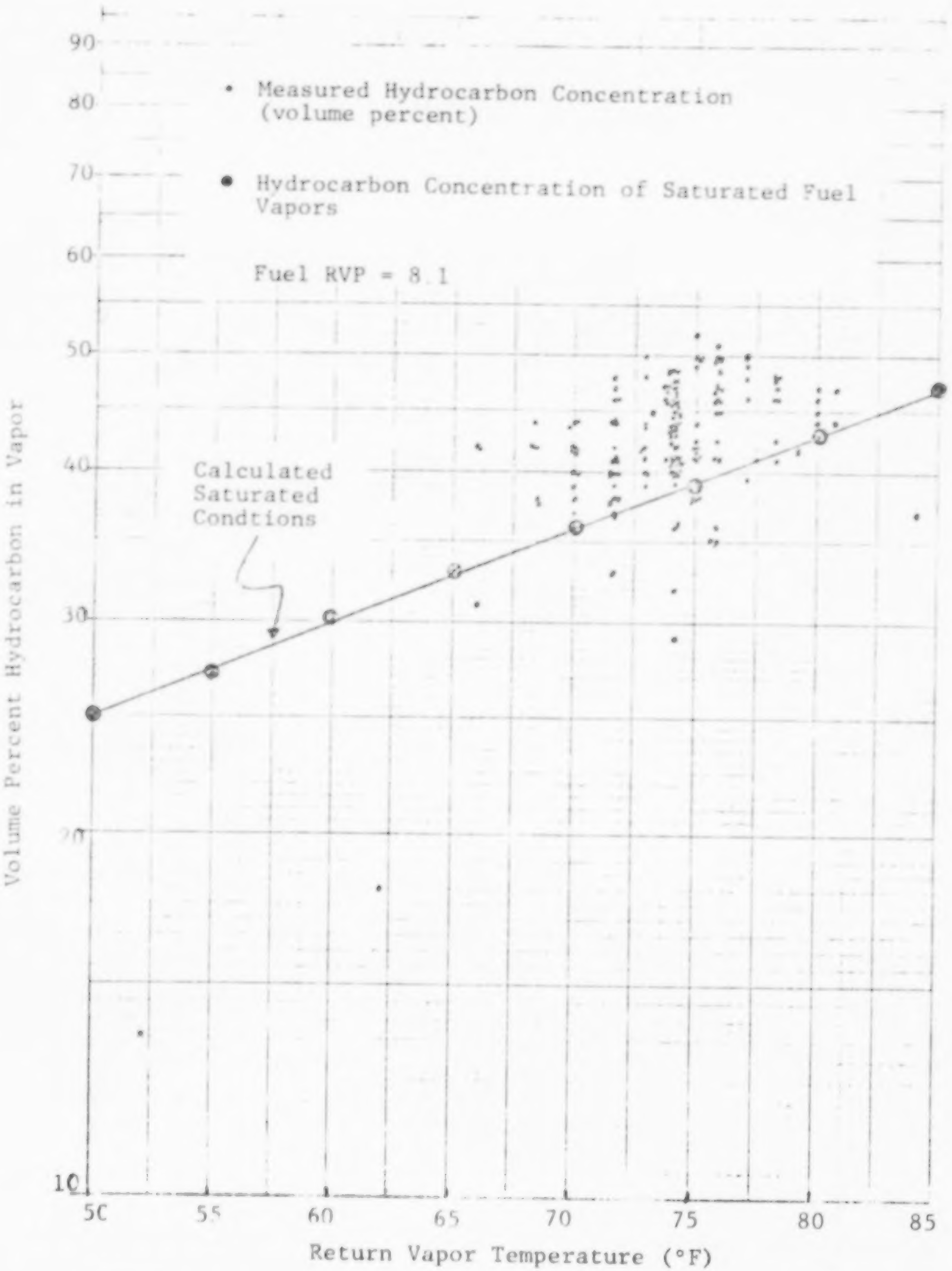

FIGURE 4.4-6 - COMPARISON OF MEASURED HYDROCARBON CONCENTRATIONS AGAINST HYDROCARBON CONCENTRATIONS OF SATURATED FUEL VAPORS

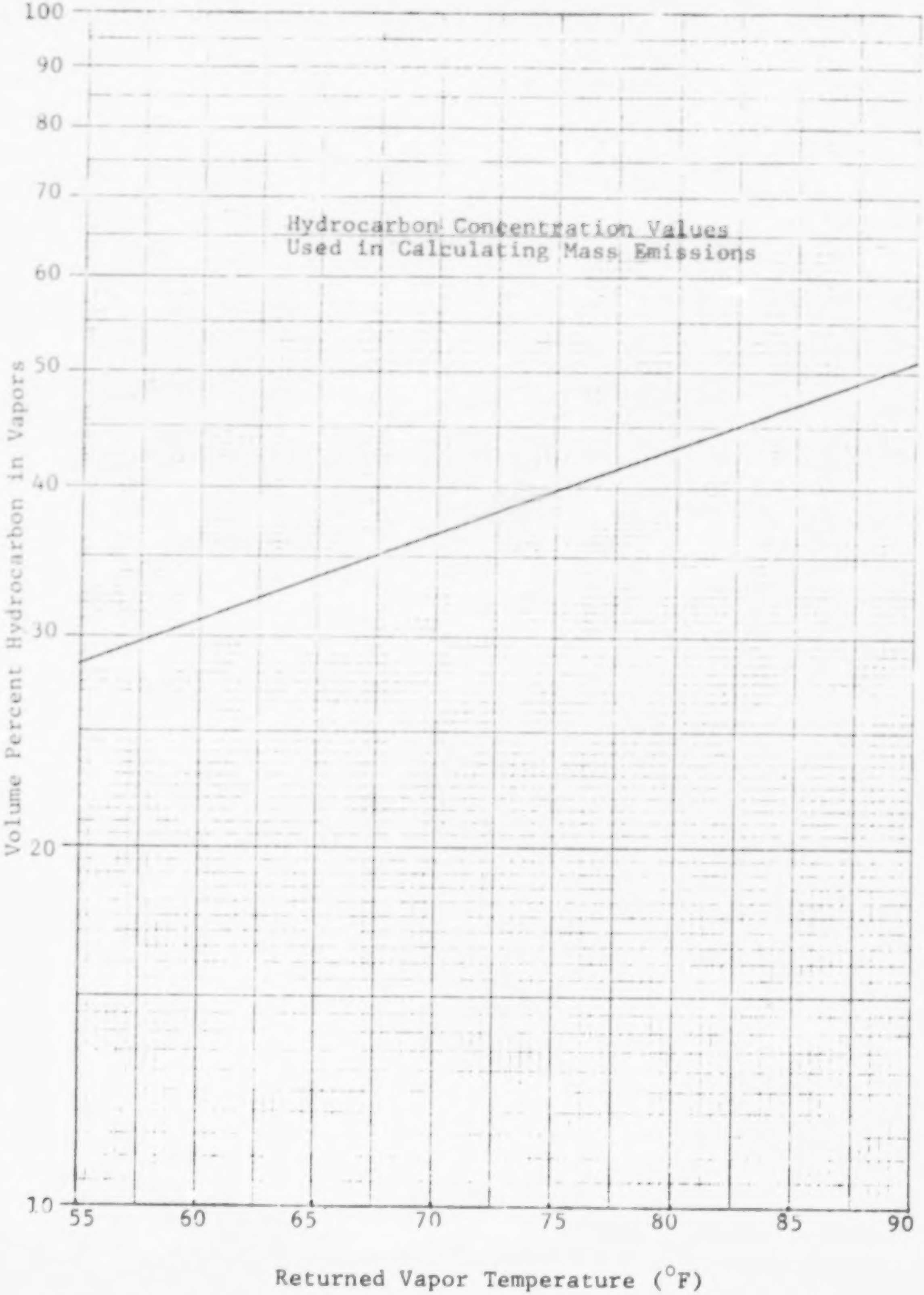

FIGURE 4.4-7 - PREDICTED HYDROCARBON CONCENTRATION AS A FUNCTION OF RETURNED VAPOR TEMPERATURE

TABLE 4.4-3
SUMMARY OF MASS EMISSIONS FOR TESTING PERFORMED 7/30/74 - 8/16/74

Test Condition	Mass Emission (gm/gal)*
Station I	
7/30 - 8/2 Type I nozzle	1.23
Station II	
8/5 - 8/8 Both nozzles	1.06
8/5 - 8/8 Type II nozzle	0.932
8/5 - 8/7 Type I nozzle	1.17
8/9 - 8/14 Type I nozzle	0.655
8/15 - 8/16 Type I nozzle	1.02

*Results are estimates. No useful hydrocarbon measurements were obtained during the tests.

efficiency approached 100%.

The results of the August 9 drop were not expected. The underground tank inbreathed a total of 41.13 ft^3 and outbreathed only 0.76 ft^3. All outbreathing occurred at the very beginning of the fill only. The pressure in the underground tank during filling was -7" H_2O which quickly rose to 0" H_2O at the termination of the fill. Both of the plastic bags covering the nozzles were collapsed and the Type II nozzle inbreathed air fairly rapidly. The Type I nozzle also appeared to inbreathe, but only a small amount. No data was taken on the flow meters connected to the nozzles, as it was anticipated that the plastic bags would prohibit all nozzle leaks. The underground tank temperature went from 72°-70° during the fill. Reasons for the large amount of inbreathing have not yet been determined.

Due to the large volume of gasoline in the underground tank, only 2059 gallons of gasoline were dropped on August 15. As in the previous measured drop, inbreathing was experienced. This time, however, only 1.128 ft^3 of air was inbreathed at the underground tank vent versus greater than 40 ft^3 for the earlier measured drop. No outbreathing was measured. The gas meters at the nozzles were also monitored and showed a total of 0.76 ft^3 of inbreathed air, 0.12 ft^3 through one nozzle and 0.64 ft^3 through the other.

4.5 Calculations

Calculation methods used to determine the vapor collection efficiency results presented in Table 4.4-1 and the mass emission results listed in Table 4.4-3 are explained below. For each calculation, the basic equation is presented. All values used in that calculation are then defined.

Basis for Vapor Collection Efficiency

$$\text{Calculated Vapor Collection Efficiency} = 100 \times \left[\frac{\text{(Actual Returned Vapors)}}{\text{(Baseline Predicted Returned Vapors)}}\right]$$

Actual Returned Vapors (ft^3) = A direct measurement found in the attached data sheets.

Baseline Predicted Returned Vapors (ft^3) = A calculated value.

$$\text{Baseline Predicted Returned Vapors } (ft^3) = \left(\text{Volume of Gasoline Dispensed}\right) \times (\text{Baseline } V/L)$$

where:

Baseline V/L is determined from the regression line formed by a least squares fit of all the baseline data obtained during the test. The regression equation is in the form:

$$V/L = a\,\Delta T + b$$

Using the measured test value for ΔT, a value for the baseline V/L is easily calculated.

Basis for Mass Emissions

$$\text{Mass Emissions}\left(\frac{gm}{gal}\right) = \left(\text{Baseline Returned Hydrocarbon}\right) - \left(\text{Actual Returned Hydrocarbon}\right)$$

Baseline Returned Hydrocarbon = A calculated value

$$\begin{array}{c}\text{Baseline Returned}\\ \text{Hydrocarbon}\end{array} = \left(\begin{array}{c}\text{Baseline Predicted}\\ \text{Returned Vapor}\end{array}\right) \times \left(\begin{array}{l}\text{Predicted}\\ \text{Hydrocarbon}\\ \text{Concentration}\end{array}\right) \times \left(\begin{array}{l}\text{Vapor}\\ \text{Density}\end{array}\right)$$

where:

$$\begin{array}{c}\text{Baseline Predicted}\\ \text{Returned Vapor}\end{array} = \text{Calculated as above}$$

and:

Predicted Hydrocarbon Concentration = Calculated from the slope and intercept of Figure 4.4-7 using the measured returned vapor temperature.

and:

Vapor Density = 82.2 gm/ft^3 (Corresponds to 65 lb/mole. A typical molecular weight for gasoline reports.)

Actual Returned Hydrocarbon = A calculated value

$$\left(\begin{array}{c}\text{Actual Returned}\\ \text{Hydrocarbon}\end{array}\right) = \left(\begin{array}{l}\text{Actual}\\ \text{Returned}\\ \text{Vapors}\end{array}\right) \times \left(\begin{array}{l}\text{Predicted}\\ \text{Hydrocarbon}\\ \text{Concentration}\end{array}\right) \times \left(\begin{array}{l}\text{Vapor}\\ \text{Density}\end{array}\right)$$

All values used in this calculation have been defined above.

4.6 Engineering Interpretation of Data

4.6.1 Inclusion of Force Fit Vehicles

Displacement system vapor recovery efficiencies and mass emissions as reported earlier in this section are based only on those vehicles which were designated as regular fill attempts. If all vehicles, except those few which had bad data, are used for the calculations the results are significantly improved. The vehicles that would be included are baseline and baseline attempt vehicles. Calculated results employing this change are as follows. Only the test values where nozzle Type I was used alone were used for this illustration

Displacement System Vapor Recovery Efficiencies

Percentage Recovery Basis

	Regular Fill Vehicles Only	Regular Fill, Baseline and Baseline Attempt Vehicles
Station I	69.6%	78.3%
Station II	83.5%	87.7%

Mass Emissions Basis (gm/gallon)

	Regular Fill Vehicles Only	Regular Fill, Baseline and Baseline Attempt Vehicles
Station I	1.23	0.883
Station II	0.655	0.487

These values are included to illustrate how the recovery can be significantly improved by operator diligence in effecting a tighter seal at the fill-neck interface.

4.6.2 Efficiencies Based on Uncontrolled Emissions

All displacement system efficiencies reported above and in previous sections have been based on baseline recoveries.

This assumes that baseline recovered vapors represent the uncontrolled vapor emissions.

Calculations based on regular vehicle fills show that 1.23 gm/gallon emissions result in a collection efficiency of 69.6% for Station I, and that 0.655 gm/gallon emissions result in a collection efficiency of 83.5%. A 0% collection efficiency would result in an uncontrolled mass emission for these stations of 4.04 and 3.97 gm/gallon, respectively.

Studies performed by Scott Laboratories (SC-167) indicate that uncontrolled emissions from vehicle refueling is 5 gm/gallon. Scott's tests were performed with a regular nozzle in a SHED.

Scott suggested that a portion of the loss could be due to entrained liquid droplets in the vapors, although this theory was not substantiated. It is conceivable that the difference in uncontrolled emissions reported by Scott and those measured in the field are due to knockout of entrained droplets from the emerging vapor stream. The type nozzles used for these tests employed large rubber face plates to make the seal at the fill neck interface, and only a relatively small vapor passage was provided. Some of the entrained vapor droplets are forced to strike against the faceplate, coalesce, and finally drop back to the underground tank.

Calculated collection efficiency results are improved if uncontrolled emissions from vehicle refueling are used as a basis of calculation instead of baseline vapor recoveries. The amount of atmospheric losses or mass emissions, however, would remain constant. The recovery efficiency calculated on the basis of uncontrolled emissions would be:

$$\text{Efficiency} = 100 \times \left[\begin{pmatrix}\text{Baseline Returned}\\ \text{Hydrocarbon}\end{pmatrix} - \begin{pmatrix}\text{Actual}\\ \text{Returned}\\ \text{Hydrocarbon}\end{pmatrix}\right] \Big/ \begin{pmatrix}\text{Uncontrolled}\\ \text{Emissions}\end{pmatrix}$$

Calculating efficiencies on this basis would raise the vapor recovery efficiency of Station 1 to about 75% and Station 2 to about 87%.

4.6.3 Recoveries Greater than 100%

Many vapor recovery efficiencies in excess of 100% were measured during this test. It has been suggested that the vapor recovery nozzle design may have been partially responsible for this.

The nozzle used for most of the testing employed a mechanical check valve which also served to latch the nozzle onto a fill neck. The opening the mechanical check valve, i.e. the vapor passage, is directly proportional to the thickness of the fill neck lip.

Baseline emissions are calculated from a least squares fit of the baseline data and are thus an average value. Likewise, the baseline represents an average opening of the check valve or vapor passage. Non-baseline vehicles possessing thick fill neck lips would cause the check valve to be open wide. The resistance to flow through the vapor passage would be less, and consequently more vapors would be displaced from the vehicle tank than indicated by baseline values; thus the calculated recovery would be greater than 100%.

This effect, if it exists, could be compounded under certain situations. For example, consider a situation where several vehicles are being simultaneously refueled with the same grade fuel and where the vapor return lines are manifolded together at the dispenser. Assuming one of these vehicles has a thick fill neck lip and that the others have extremely thin fill neck lips, it is feasible that the vacuum created in the underground tank would strongly affect those vapors experiencing the least flow resistance. The displacement system could possibly, in this situation, behave as a vacuum assist system and "pull" vapors from the vehicle tank with the thick lip while, at the same time, recovering only a small amount of vapors from the other vehicles.

This is an area which has many unanswered questions. Further analysis of existing data and possibly even further testing is needed to attempt to resolve these questions.

4.6.4 Data Summary Sheets

Vehicles marked with an asterisk (*) have corrected dispensed fuel temperatures.

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	7/30/74	A- 1	78BFJN	1972	CHEVROLET	GOOD	NO	0	70	2.40	0.04	70	69	10.0	1.423	4.65
EXXON	7/30/74	A- 2	12169M	1972	DODGE	GOOD	NO	0	63	1.30	0.06	70	70	5.4	0.328	4.26
EXXON	7/30/74	A- 3	999KTP	1974	FORD	GOOD	NO	0	66	2.40	0.07	70	68	8.9	1.354	4.77
EXXON	7/30/74	A- 4	NKT488	1965	VOLKSWAGON	POOR	NO	100	63	0.00	-0.02	70	71	8.0	1.596	5.11
EXXON	7/30/74	A- 5	G30014	19 0	CHEVROLET	GOOD	NO	0	68	0.00	-0.03	70	70	5.4	1.028	4.98
EXXON	7/30/74	A- 6	115VPY	1970	PONTIAC	POOR	NO	100	84	3.00	-0.03	72	73	5.4	1.153	4.76
EXXON	7/30/74	A- 7	YHW771	1969	VOLKSWAGON	GOOD	NO	100	70	0.00	-0.03	70	71	5.4	-0.335	-1.00
EXXON	7/30/74	A- 8	WKS889	19 0	BUICK	POOR	NO	100	77	0.00	0.02	72	72	5.4	0.277	4.91
EXXON	7/30/74	A- 9	RGN845	19 0	FORD	GOOD	NO	0	73	0.00	-0.08	70	72	5.4	0.472	4.84
EXXON	7/30/74	A-10	MML539	1965	OLDSMOBILE	GOOD	NO	5	91	0.00	-0.07	72	76	17.3	1.174	3.44
EXXON	7/30/74	A-11	504JYF	1973	FORD	GOOD	NO	0	72	0.00	0.04	75	78	5.4	0.872	4.50
EXXON	7/30/74	A-12	YJU255	1969	FORD	GOOD	NO	100	75	0.00	-0.06	76	78	15.5	0.246	7.38
EXXON	7/30/74	A-13	30731J	1972	FORD	GOOD	NO	100	75	0.00	-0.11	72	76	10.7	0.746	8.68
EXXON	7/30/74	A-14	Q20571	1967	FORD	GOOD	NO	60	74	0.00	-0.20	74	77	9.1	0.015	-1.00
EXXON	7/30/74	A-15	55676H	1969	DATSUN	GOOD	NO	35	77	0.00	0.08	74	78	5.4	0.719	4.44
EXXON	7/30/74	A-16	470JHW	1973	VOLKSWAGON	GOOD	NO	0	71	0.00	0.06	72	79	9.7	1.315	4.81
EXXON	7/30/74	A-17	077CVO	1972	DATSUN	POOR	NO	100	74	0.00	0.07	75	80	5.4	0.004	4.32
EXXON	7/30/74	A-18	V296	1965	PLYMOUTH	GOOD	NO	100	74	0.00	0.12	74	76	11.2	1.053	4.70
EXXON	7/30/74	A-19	C71170	1962	CHEVROLET	GOOD	NO	100	66	0.00	-0.08	71	74	7.2	0.237	4.65
EXXON	7/30/74	A-20	498DGY	1971	TOYOTA	GOOD	NO	60	76	0.00	-0.15	71	74	8.2	1.088	4.78
EXXON	7/30/74	A-21	41970R	1959	CHEVROLET	POOR	NO	100	73	0.00	-0.04	72	79	7.2	0.103	4.97
EXXON	7/30/74	A-22	972BWL	1970	CHEVROLET	GOOD	NO	10	81	0.00	-0.03	72	76	7.8	0.896	4.78
EXXON	7/30/74	A-23	RRA-962	1969	CHEVROLET	GOOD	NO	80	72	0.00	0.13	74	78	5.4	0.752	7.36
EXXON	7/30/74	A-24	093JVT	1972	VOLKSWAGON	POOR	NO	100	72	0.00	0.06	72	78	9.2	1.072	4.68
EXXON	7/30/74	A-25	404ERT	1972	FORD	GOOD	NO	0	73	0.00	0.12	71	74	12.5	1.938	9.04
EXXON	7/30/74	A-26	DJR-460	1960	FORD	POOR	NO	100	73	0.00	-0.08	71	76	10.6	0.679	4.58
EXXON	7/30/74	A-27	ZPN472	1969	CHEVROLET	POOR	NO	100	83	0.00	-0.02	72	73	13.3	1.325	4.69
EXXON	7/30/74	B- 1	PA4444	1971	FORD	GOOD	NO	100	73	0.45	0.08	72	66	5.5	0.540	4.71
EXXON	7/30/74	B- 2		1963	CHRYSLER	GOOD	NO	100	90	0.00	-0.08	71	68	14.3	1.290	4.93
EXXON	7/30/74	B- 3	YKMR25	1968	CADILLAC	GOOD	NO	100	90	0.00	-0.25	74	70	16.0	0.017	4.92
EXXON	7/30/74	B- 4	542CLB	1962	CADILLAC	GOOD	NO	0	80	0.00	-0.20	75	70	16.7	0.331	5.01
EXXON	7/30/74	B- 5	AGH326	1965	VOLKSWAGON	GOOD	NO	0	67	0.00	0.00	73	71	5.4	0.563	9.53
EXXON	7/30/74	B- 6	268885	1974	CHEVROLET	GOOD	YES	60	77	-0.04	0.02	74	71	11.7	1.471	4.39
EXXON	7/30/74	B- 7	617HKS	1973	MERCURY	GOOD	NO	0	70	0.88	0.18	76	72	10.1	2.992	1.91
EXXON	7/30/74	B- 8	356LCP	1973	DODGE	GOOD	NO	100	85	0.80	0.02	76	74	12.2	1.590	4.98
EXXON	7/30/74	B- 9	717KIZ	1974	FORD	GOOD	NO	0	73	0.65	0.03	80	76	5.7	1.019	4.44
EXXON	7/30/74	B-10	SDT582	1966	CHEVROLET	GOOD	NO	0	76	0.00	0.01	78	77	10.0	1.098	4.80

```
LICENSE    VAPOR  DELTA  VEHICLE            SAT    BASE    ACT    AMT    HC %     HC
           LIQUID TEMP   DESIGNATION        HC     RET     RET    HC     RECV   EMISS
           RATIO                            CONC   HC      HC     LOST   BASE   GM/GAL
788FJN      1.06     0 BASELINE            36.0   40.4    42.1   -1.7   104.2 -0.169
12169M      0.45    -7 FORCE FIT           36.6   24.5     9.9   14.6    40.3  2.707
999KTP      1.14    -4 BASELINE            35.4   37.5    39.4   -1.9   105.2 -0.217
NKT488      1.49    -7 REGULAR             37.2   36.9    48.8  -11.9   132.3 -1.491
Q30014      1.42    -2 BASELINE            36.6   22.8    30.9   -8.1   135.4 -1.496
115VPY      1.60    12 FORCE FIT           38.5   19.2    36.4  -17.3   190.2 -3.200
YHW771     -0.46     0 REGULAR             37.2   22.6   -10.2   32.8   -45.4  6.073
WKS889      0.38     5 FORCE FIT           37.6   21.2     8.6   12.6    40.6  2.337
RGN845      0.65     3 REGULAR             37.8   21.9    14.7    7.2    67.0  1.340
MML539      0.51    19 REGULAR             40.4   56.4    39.0   17.4    69.2  1.005
504JYF      1.21    -3 BASELINE            41.8   26.5    30.0   -3.5   113.2 -0.647
YJU255      0.12    -1 FORCE FIT           41.8   73.8     8.4   65.3    11.5  4.216
30731J      0.52     3 REGULAR             40.4   46.4    24.8   21.6    53.4  2.020
Q20571      0.01     0 REGULAR             41.1   42.0     0.5   41.5     1.2  4.558
55676H      1.00     3 REGULAR             41.8   24.2    24.7   -0.5   102.0 -0.090
470JHW      1.01    -1 REGULAR             42.5   47.0    45.9    1.0    97.8  0.106
077CVO      0.01    -1 REGULAR             43.2   26.6     0.1   26.4     0.5  4.895
V296        0.70     0 REGULAR             40.4   50.8    35.0   15.8    68.8  1.414
C71170      0.25    -5 FORCE FIT           39.1   33.9     7.6   26.3    22.4  3.657
498DGY      0.99     5 REGULAR             39.1   33.3    35.0   -1.6   104.9 -0.200
41970R      0.11     1 REGULAR             42.5   33.8     3.6   30.2    10.6  4.199
972BWL      0.86     9 REGULAR             40.4   30.7    29.8    0.9    97.1  0.116
RRA-962     1.04    -2 REGULAR             41.8   26.1    25.8    0.3    99.0  0.047
093JVT      0.87     0 REGULAR             41.8   43.2    36.8    6.3    85.3  0.689
404ERT      1.16     2 BASELINE            39.1   53.2    62.3   -9.0   117.0 -0.724
DJR-460     0.48     2 REGULAR             40.4   46.7    22.6   24.1    48.3  2.275
ZPN472      0.75    11 REGULAR             38.5   48.1    41.9    6.2    87.2  0.464
PA4444      0.73     1 FORCE FIT           34.2   20.8    15.2    5.6    73.0  1.024
            0.67    19 REGULAR             35.4   40.8    37.5    3.3    92.0  0.230
YKM825      0.00    16 REGULAR             36.6   50.1     0.5   49.6     1.0  3.101
542CLB      0.15     5 REGULAR             36.6   63.5    10.0   53.6    15.7  3.207
AGH326      0.78    -6 REGULAR             37.2   24.6    17.2    7.3    70.1  1.360
268885      0.94     3 FORCE FIT           37.2   46.7    45.0    1.7    96.3  0.146
617HKS      1.24    -6 BASELINE            37.8   83.7    93.0   -9.3   111.1 -0.515
356LCP      0.97     9 FORCE FIT           39.1   46.4    51.1   -4.7   110.1 -0.385
717KIZ      1.34    -7 BASELINE            40.4   28.5    33.9   -5.3   116.6 -0.931
SDT582      0.82    -2 REGULAR             41.1   47.5    37.1   10.4    78.1  1.041
```

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	7/30/74	B-11	URA601	1966	FORD	GOOD	NO	0	72	0.00	0.05	76	75	5.3	0.877	-1.00
EXXON	7/30/74	B-12	GF1448	1967	VOLKSWAGON	GOOD	NO	0	68	0.00	0.04	75	75	5.4	0.845	4.84
EXXON	7/30/74	B-13	178CSF	1973	VOLKSWAGON	GOOD	NO	0	73	0.00	-0.15	77	74	8.3	0.139	-1.00
EXXON	7/30/74	B-14	140FIW	1973	FORD	GOOD	NO	0	75	0.00	0.05	77	75	8.8	1.224	4.89
EXXON	7/30/74	B-15	FS9151	1973	GMC	POOR	YES	0	80	0.00	0.00	76	76	10.2	0.368	-1.00
EXXON	7/30/74	B-16	803JUJ	1974	FORD	GOOD	NO	0	0	0.00	0.03	78	63	5.4	0.718	5.06
EXXON	7/30/74	B-17	761415	1974	DODGE	GOOD	NO	0	73	0.00	0.04	78	76	7.2	1.016	6.00
EXXON	7/30/74	B-18	97814U	1972	FORD	GOOD	NO	100	83	0.00	-0.02	79	78	9.4	0.779	7.14
EXXON	7/30/74	B-19	ASH892	1964	OLDSMOBILE	GOOD	NO	0	74	0.00	0.05	78	78	8.0	1.120	4.49
EXXON	7/30/74	B-20	25037P	1973	DODGE	GOOD	NO	0	76	0.00	0.02	74	72	15.9	1.877	8.38
EXXON	7/30/74	B-21	333FCO	1971	CHEVROLET	GOOD	NO	0	88	0.00	0.13	74	72	14.3	1.767	7.09
EXXON	7/30/74	B-22	CLB045	1962	MERCURY	GOOD	NO	0	77	0.00	0.05	77	76	9.7	1.258	6.47
EXXON	7/30/74	B-23	136JIX	1973	VOLKSWAGON	GOOD	NO	0	72	0.00	0.16	74	73	9.4	1.357	-1.00
EXXON	7/30/74	B-24	770GQF	1973	MAZDA	POOR	NO	100	79	0.00	0.16	74	73	12.6	0.020	4.91
EXXON	7/30/74	B-25	287JAR	1971	PLYMOUTH	GOOD	NO	0	74	0.00	0.01	77	77	16.6	2.292	4.77
EXXON	7/30/74	B-26	269KTG	1974	TOYOTA	POOR	NO	100	74	0.00	-0.05	75	74	8.6	0.022	4.53
EXXON	7/30/74	B-27	977GMY	1972	OLDSMOBILE	GOOD	NO	0	75	0.00	0.06	75	75	7.5	0.870	5.00
EXXON	7/31/74	A- 1	181CMC	1967	FORD	GOOD	YES	0	64	0.00	-0.12	72	68	10.0	0.257	5.26
EXXON	7/31/74	A- 2	SPP720"'	1967	EVROLET	GOOD	NO	100	73	0.00	-0.16	68	66	5.0	0.343	5.00
EXXON	7/31/74	A- 3	193ROF	1969	AUSTIN	GOOD	NO	0	64	0.00	0.04	68	66	8.7	1.192	4.66
EXXON	7/31/74	A- 4	858DRK	1971	FORD	GOOD	NO	100	62	0.00	0.01	68	64	5.4	1.033	5.14
EXXON	7/31/74	A- 5	UXM760	1967	FORD	GOOD	NO	100	63	0.00	0.12	66	64	9.3	1.133	8.72
EXXON	7/31/74	A- 6	XPU480	1969	VOLKSWAGON	GOOD	NO	0	60	0.00	0.04	62	67	7.1	0.778	5.28
EXXON	7/31/74	A- 7	G1150491	1971	AMER MOTOR	GOOD	NO	100	67	0.00	-0.03	69	67	10.0	0.645	3.47
EXXON	7/31/74	A- 8	SGW006	1961	CHEVROLET	GOOD	NO	5	0	0.00	0.01	72	69	5.9	0.933	4.60
EXXON	7/31/74	A- 9	39906J	1966	FORD	POOR	NO	100	71	0.00	0.12	73	71	12.5	1.245	5.51
EXXON	7/31/74	A-10	708JIE	1973	FORD	GOOD	NO	100	78	0.00	0.02	73	76	11.0	1.280	4.02
EXXON	7/31/74	A-11	R46239	19 0	CHEVROLET	POOR	NO	100	68	0.00	0.04	72	72	5.4	0.606	5.49
EXXON	7/31/74	A-12	WDK111	1967	VOLKSWAGON	GOOD	NO	0	68	0.00	-0.05	72	71	7.4	0.026	4.15
EXXON	7/31/74	A-13	792KDL	1974	TOYOTA	GOOD	NO	0	73	0.00	0.02	73	72	5.4	0.734	5.31
EXXON	7/31/74	A-14	748AMV	1970	VOLKSWAGON	GOOD	NO	100	63	0.00	0.03	74	72	9.2	0.889	4.18
EXXON	7/31/74	A-15	TF328	1965	FORD	GOOD	NO	0	69	0.00	-0.02	73	72	5.4	0.330	4.98
EXXON	7/31/74	A-16	960KDV	1973	DODGE	GOOD	NO	0	79	0.00	-0.04	72	72	5.4	0.668	4.91
EXXON	7/31/74	A-17	206CST	1971	BUICK	GOOD	NO	0	74	0.00	0.06	73	74	9.0	0.478	6.44
EXXON	7/31/74	A-18	346EDM	1970	BUICK	GOOD	NO	0	85	0.00	0.02	76	76	5.4	0.498	4.78
EXXON	7/31/74	A-19	0720453	1974	GMC	GOOD	NO	0	79	0.00	0.02	75	74	8.6	1.118	4.69
EXXON	7/31/74	A-20	XLB687	1962	CHEVROLET	GOOD	NO	100	81	0.00	0.07	73	74	14.7	1.760	-1.00

LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
URA601	1.24	-4	FORCE FIT	39.8	25.1	28.7	-3.6	114.4	-0.680
GP1448	1.17	-7	BASELINF	39.8	26.6	27.6	-1.0	103.8	-0.187
178CSF	0.13	-4	BAD READING	39.1	38.6	4.5	34.1	11.6	4.112
140FIW	1.04	-2	REGULAR	39.8	40.4	40.0	0.4	98.9	0.050
FS9151	0.27	4	BAD READING	40.4	43.5	12.2	31.3	28.1	3.070
803JUJ	0.99	-78	INST. FAIL.	32.6	42.6	19.2	23.4	45.0	4.336
76141S	1.06	-5	REGULAR	40.4	35.1	33.8	1.3	96.2	0.186
97814U	0.62	4	REGULAR	41.8	41.5	26.8	14.7	64.5	1.566
ASH892	1.05	-4	BASELINE	41.8	39.8	38.5	1.3	96.8	0.161
25037P	0.88	2	BASELINE	37.8	65.5	58.4	7.2	89.1	0.450
333FCO	0.92	14	BASELINF	37.8	48.1	54.9	-6.8	114.2	-0.477
CLB045	0.96	0	BASELINE	40.4	44.0	41.5	2.5	94.4	0.256
136JIX	1.08	-2	FORCE FIT	38.5	41.8	42.9	-1.1	102.7	-0.118
770GOF	0.01	5	REGULAR	38.5	50.4	0.6	49.7	1.3	3.947
287JAR	1.03	-3	BASELINE	41.1	80.0	77.1	2.9	96.4	0.175
269KTG	0.02	-1	REGULAR	39.1	38.3	0.7	37.6	1.8	4.373
977GMY	0.87	0	BASELINE	39.8	33.5	28.4	5.0	84.9	0.672
181CMC	0.19	-8	REGULAR	35.4	44.4	7.5	37.0	16.8	3.697
SPP720"'	0.51	5	REGULAR	34.2	17.8	9.7	8.1	54.3	1.628
19380F	1.02	-4	REGULAR	34.2	35.4	33.5	1.9	94.7	0.216
858DRK	1.43	-6	REGULAR	33.1	21.9	28.1	-6.3	128.6	-1.159
UXM760	0.91	-3	REGULAR	33.1	36.1	30.8	5.3	85.4	0.567
XPU480	0.82	-2	REGULAR	34.8	28.6	22.3	6.3	77.9	0.888
G1150491	0.48	-2	FORCE FIT	34.8	40.2	18.5	21.5	45.9	2.178
SGW006	1.18	-72	INST. FAIL.	36.0	49.3	27.6	21.7	56.0	3.675
39906J	0.75	-2	REGULAR	37.2	53.8	38.1	15.7	70.8	1.255
708JIE	0.87	5	REGULAR	40.4	46.2	42.5	3.7	92.0	0.335
R46239	0.84	-4	REGULAR	37.8	24.3	18.8	5.4	77.6	1.009
WDK111	0.03	-4	BASELINE	37.2	32.7	0.8	31.9	2.4	4.317
792KDL	1.02	0	BASELINE	37.8	22.9	22.8	0.1	99.5	0.020
748AMV	0.72	-11	REGULAR	37.8	45.4	27.6	17.8	60.8	1.935
TF328	0.46	-4	FORCE FIT	37.8	24.3	10.3	14.0	42.2	2.598
960KDV	0.91	7	BASELINE	37.8	20.6	20.5	0.0	99.9	0.006
206CSI	0.39	1	REGULAR	39.1	38.9	15.1	23.8	38.8	2.646
346EDM	0.68	9	BASELINE	40.4	21.2	16.3	5.0	76.7	0.917
0720453	0.97	4	BASELINE	39.1	35.5	35.7	-0.2	100.5	-0.019
XLB687	0.90	8	REGULAR	39.1	56.9	56.6	0.3	99.5	0.021

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STATION    DATE    TEST LICENSE   YEAR    MAKE       TYPE SPT EXP VEH   VEH    SYS GAS VAP AMT     VOL          DISP
                    NO                                OF  BAK RDG  TK    TK    PRES TMP TMP GAS     VAP          RATE
                                                     FIT          TMP  PRES                         DISP

EXXON     7/31/74 A-21 353EZC    1963 MERCURY     GOOD NO    0  81  0.00   0.03 73 73   5.4     0.610        4.76
EXXON     7/31/74 A-22 22459P    1973 CHEVROLET   GOOD NO  100  76  0.00  -0.04 73 76   9.0     1.110        4.02
EXXON     7/31/74 A-23 069ALK    1970 PLYMOUTH    GOOD NO    0  83  0.00   0.04 74 76   3.5     0.390        3.09
EXXON     7/31/74 A-24 XPV138    1969 TOYOTA      GOOD NO  100  69  0.00  -0.09 73 74  14.7     0.990        4.09
EXXON     7/31/74 A-25 88-404    1959 FORD        GOOD NO    0  76  0.00   0.09 71 74   5.4     0.860        4.84
EXXON     7/31/74 A-26 AXK587    1963 DODGE       GOOD NO  100  72  0.00   0.14 74 72   9.0     1.300        5.00
EXXON     7/31/74 A-27 TCX144    1966 FORD        GOOD NO    0  88  0.00   0.02 75 75   5.4     0.550        4.91
EXXON     7/31/74 A-28 Q30014    1967 CHEVROLET   GOOD NO   25  75  0.00   0.05 77 76   5.4     0.810        5.06
EXXON     7/31/74 A-29 KBP236    1963 FORD        GOOD NO  100  82  0.00   0.10 74 76  14.3     1.450        4.02
EXXON     7/31/74 A-30 44792R    1971 DATSUN      GOOD NO  100  73  0.00   0.03 76 76  13.2     0.340       10.03
EXXON     7/31/74 A-31 C84860    1964 FORD        GOOD NO  100  77  0.00   0.03 77 78  10.7     0.790       -1.00
EXXON     7/31/74 B- 1 453KSK    1971 CHEVROLET   GOOD NO  100  81  0.00  -0.16 70 64  12.0     1.400        8.09
EXXON     7/31/74 B- 2 BYH684    1959 CHEVROLET   GOOD NO    0  69  0.00   0.08 69 66  17.3     2.440        4.05
EXXON     7/31/74 B- 3 TMT205    1964 FORD        GOOD NO  100  68  0.00  -0.05 70 64   8.9     0.710        6.07
EXXON     7/31/74 B- 4 941GTS    1972 OPEL        GOOD NO  100  68  0.00  -0.04 70 64   9.8     0.530        4.74
EXXON     7/31/74 B- 5 923AHI    1959 GMC         GOOD NO    0  67  0.00   0.04 70 64   5.3     0.700        4.61
EXXON     7/31/74 B- 6 KEB745    1962 VOLKSWAGON  GOOD NO    0  67  0.00   0.08 70 68   5.4     0.730        5.14
EXXON     7/31/74 B- 7 028KDE    1969 OLDSMOBILE  GOOD NO    0  69  0.00   0.03 70 68  10.1     1.260        4.04
EXXON     7/31/74 B- 8 MOM843    1964 FORD        GOOD NO    0  65  0.00   0.02 72 67  10.7     1.500        4.90
EXXON     7/31/74 B- 9 MKB050    1964 FORD        GOOD NO    0  73  0.00  -0.22 72 70   5.4     0.720        4.04
EXXON     7/31/74 B-10 466AWT    1962 CHEVY       GOOD NO   80  69  0.90   0.04 74 70   5.4     0.800        4.44
EXXON     7/31/74 B-11 690JTC    1973 GMC         GOOD NO  100  71  0.00   0.02 74 70   5.4     1.220        4.04
EXXON     7/31/74 B-12 794JTB    1973 TOYOTA      GOOD NO  100  68  0.00   0.03 74 72   4.8     0.490        4.17
EXXON     7/31/74 B-13 555HKS    1973 LINCOLN     GOOD NO    0  75  2.50   0.20 76 74  12.3     1.730        7.45
EXXON     7/31/74 B-14 879397    1960 CHEVROLET   GOOD NO    0  67  0.00   0.06 73 72  14.5     2.100        4.75
EXXON     7/31/74 B-15 HOE171    1965 FORD        GOOD NO   25  66  0.00   0.03 73 72  14.5     2.110        4.61
EXXON     7/31/74 B-16 DZF743    1962 DODGE       GOOD YES 100  72  0.00  -0.02 73 72   6.9     0.360        4.45
EXXON     7/31/74 B-17 10233M    1972 FORD        GOOD NO    0  70  0.00   0.04 73 72  16.4     2.290       -1.00
EXXON     7/31/74 B-17 10233M    1972 FORD        GOOD NO  100  74  0.00   0.04 73 72  11.4     0.700       -1.00
EXXON     7/31/74 B-18 TJH386    1967 CHEVROLET   GOOD NO  100  73  0.00   0.03 73 73   5.4     0.600        5.23
EXXON     7/31/74 B-19 070AWY    1962 MERCURY     GOOD NO    0  73  0.00   0.10 73 76   5.4     0.770        4.04
EXXON     7/31/74 B-20 324 JKN   1970 VOLKSWAGON  GOOD NO  100  76  0.00   0.02 75 75  10.0     1.250        4.44
EXXON     7/31/74 B-21 VAA970    1967 FORD        GOOD NO  100  72  0.00   0.02 75 75  14.3     1.320        4.71
EXXON     7/ 0/74 B-22 RJZ111    1965 CHEVROLET   GOOD NO  100  77  0.00  -0.10 75 75   5.4     0.610        7.00
EXXON     7/31/74 B-22 G1143142  1968 CHEVROLET   GOOD NO  100  90  0.00  -0.04 74 75  10.2     0.720        4.71
EXXON     7/31/74 B-23 RWP674    1966 VOLKSWAGON  GOOD NO    0  73  0.00   0.04 75 75   8.0     1.040        4.95
EXXON     7/31/74 B-24 TCE341    1964 VOLKSWAGON  GOOD NO    0  70  0.00  -0.20 75 75   5.4     0.730        7.90
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LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
353EZC	0.84	8	BASELINE	38.5	20.5	19.3	1.3	93.8	0.234
22459P	0.92	3	FORCE FIT	40.4	39.0	36.9	2.1	94.5	0.238
069ALK	0.83	9	BASELINE	40.4	13.8	13.0	0.8	94.1	0.230
XPV138	0.50	-4	REGULAR	39.1	68.4	31.8	36.5	46.5	2.486
B8-404	1.19	5	FORCE FIT	39.1	21.9	27.6	-5.7	125.9	-1.054
AXK587	1.08	-2	REGULAR	37.8	39.4	40.4	-1.1	102.7	-0.119
TCX144	0.76	13	BASELINE	39.8	19.5	18.0	1.5	92.4	0.275
Q30014	1.12	-2	REGULAR	40.4	25.2	26.9	-1.7	106.7	-0.311
KBP236	0.76	6	REGULAR	40.4	57.2	48.2	9.0	84.2	0.631
44792R	0.19	-3	REGULAR	40.4	62.6	11.3	51.3	18.1	3.884
C84860	0.55	0	REGULAR	41.8	50.2	27.1	23.1	54.1	2.155
453KSK	0.87	11	REGULAR	33.1	37.3	38.1	-0.8	102.1	-0.064
BYH684	1.05	0	BASELINE	34.2	66.5	68.7	-2.2	103.3	-0.126
TMT205	0.60	-2	REGULAR	33.1	34.1	19.3	14.7	56.7	1.657
941GTS	0.40	-2	FORCE FIT	33.1	37.5	14.4	23.1	38.5	2.356
923AHI	0.99	-3	BASELINE	33.1	20.6	19.1	1.5	92.6	0.288
KEB745	1.01	-3	REGULAR	35.4	22.4	21.2	1.2	94.8	0.217
028KDE	0.93	-1	REGULAR	35.4	40.7	35.7	4.1	90.0	0.403
MOM843	1.10	-7	REGULAR	34.8	46.2	45.2	0.9	98.0	0.088
MKB050	1.00	1	BASELINE	36.6	21.9	21.7	0.2	99.1	0.037
466AWT	1.11	-5	FORCE FIT	36.6	23.8	24.1	-0.2	101.0	-0.044
690JTC	1.69	-3	REGULAR	36.6	23.2	36.7	-13.5	158.4	-2.505
794JTB	0.76	-6	FORCE FIT	37.8	22.2	15.2	7.0	68.6	1.450
555HKS	1.05	-1	BASELINE	39.1	54.8	55.6	-0.8	101.5	-0.065
B79397	1.08	-6	BASELINE	37.8	67.1	65.3	1.8	97.4	0.121
HOE171	1.09	-7	REGULAR	37.8	68.0	65.6	2.4	96.5	0.163
DZF743	0.39	-1	REGULAR	37.8	29.7	11.2	18.5	37.6	2.687
10233M	1.04	-3	REGULAR	37.8	72.7	71.2	1.5	97.9	0.093
10233M	0.51	1	REGULAR	37.8	47.7	24.3	23.4	50.9	2.056
TJH386	0.83	0	REGULAR	38.5	23.3	19.0	4.3	81.4	0.805
070AWY	1.07	0	REGULAR	40.4	24.5	25.6	-1.1	104.4	-0.200
324 JKN	0.93	1	REGULAR	39.8	44.0	40.8	3.1	92.9	0.312
VAA970	0.69	-3	REGULAR	39.8	66.7	43.1	23.5	64.7	1.645
RJZ111	0.84	2	REGULAR	39.8	23.4	19.9	3.5	85.2	0.639
G1143142	0.53	16	REGULAR	39.8	34.7	23.5	11.2	67.8	1.898
RWP674	0.97	-2	FORCE FIT	39.8	36.8	34.0	2.8	92.4	0.347
TCE341	1.01	-5	FORCE FIT	39.8	25.9	23.9	2.0	92.2	0.376

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	7/31/74	B-25	77002C	1969	CHEVROLET	POOR	NO	100	72	0.00	-0.20	75	75	16.1	0.010	5.14
EXXON	7/31/74	B-26	0720452	1974	GMC	GOOD	NO	0	76	0.00	0.02	72	74	5.4	0.600	5.00
EXXON	7/31/74	B-27	VJL292	1968	CHRYSLER	GOOD	NO	100	90	0.00	-0.06	75	75	17.8	1.930	5.53
EXXON	7/31/74	B-28	588DRN	1971	OPEL	GOOD	NO	0	79	0.00	0.05	75	75	5.4	0.760	4.10
EXXON	7/31/74	B-29	199KNZ	1974	VOLKSWAGON	GOOD	NO	5	78	0.00	0.04	75	75	5.4	0.800	4.70
EXXON	7/31/74	B-30	393GTA	1973	FORD	GOOD	NO	85	76	0.00	-0.16	75	75	5.4	0.790	4.50
EXXON	8/ 1/74	A- 1	10527V	1961	FORD	GOOD	NO	0	83	0.00	0.09	72	72	5.4	0.660	5.14
EXXON	8/ 1/74	A- 2	TF32H	1965	FORD	GOOD	NO	0	77	0.00	-0.07	73	73	5.4	*-151.	4.26
EXXON	8/ 1/74	A- 3	BYN287	1962	MERCURY	GOOD	NO	40	74	0.00	0.04	77	76	9.2	1.160	5.87
EXXON	8/ 1/74	A- 4	ZET165	1969	TRIUMPH	POOR	NO	100	83	0.00	-0.03	74	74	5.4	0.340	4.70
EXXON	8/ 1/74	A- 5	223YYJ	19 0	PORSCHE	POOR	NO	100	82	0.00	-0.15	73	75	5.4	0.000	3.52
EXXON	8/ 1/74	A- 6	26808S	1974	CHEVROLEo	GOOD	NO	10	79	0.00	0.04	73	72	5.4	0.730	4.56
EXXON	8/ 1/74	A- 7	12169M	1972	DODGE	GOOD	NO	100	73	0.00	-0.01	73	72	5.5	0.490	4.46
EXXON	8/ 1/74	A- 8	379GFE	1972	CHEVROLET	GOOD	NO	100	80	0.00	0.03	69	74	9.0	1.260	4.66
EXXON	8/ 1/74	A- 9	624LBF	1974	FORD	GOOD	NO	30	96	0.00	-0.02	73	76	11.3	1.120	4.88
EXXON	8/ 1/74	A-10	407EDD	1968	CHEVROLET	GOOD	NO	0	102	0.00	-0.03	72	75	5.4	0.080	4.63
EXXON	8/ 1/74	A-11	880KDY	1974	FORD	GOOD	NO	0	74	0.00	0.05	73	75	7.3	1.000	4.52
EXXON	8/ 1/74	A-12	97490W	1966	FORD	POOR	NO	100	87	0.00	-0.02	75	76	20.8	0.220	6.53
EXXON	8/ 1/74	A-13	UCW618	1967	FORD	GOOD	NO	100	105	0.00	0.01	73	77	10.7	0.360	4.37
EXXON	8/ 1/74	A-14	023HKK	1973	OLDSMOBILE	GOOD	NO	100	0	0.00	0.01	75	79	20.6	1.710	5.75
EXXON	8/ 1/74	A-15	CHW-632	1959	VOLKSWAGON	POOR	NO	100	85	0.00	-0.05	73	77	9.4	0.150	5.42
EXXON	8/ 1/74	A-16	24563P	1972	FORD	GOOD	NO	0	0	0.00	0.05	73	76	9.0	1.280	4.83
EXXON	8/ 1/74	A-17	BSA114	1962	CHEVROLET	GOOD	NO	0	83	0.00	0.44	75	79	5.4	0.970	3.00
EXXON	8/ 1/74	A-18	UBW517	1967	VOLKSWAGON	GOOD	NO	0	80	0.00	-0.14	76	77	9.6	0.430	4.88
EXXON	8/ 1/74	A-19	665CLY	1971	FORD	GOOD	NO	35	93	0.00	-0.12	75	79	7.2	0.540	4.70
EXXON	8/ 1/74	A-20	TLZ-429	1967	MERCURY	GOOD	NO	0	95	0.00	-0.14	75	80	5.4	0.180	6.75
EXXON	8/ 1/74	A-21	787DGJ	1971	CHEVROLET	GOOD	NO	100	95	0.00	-0.12	73	76	15.2	1.320	4.41
EXXON	8/ 1/74	A-22	ABY947	1963	PLYMOUTH	GOOD	NO	0	78	0.00	0.01	74	0	5.6	0.440	4.30
EXXON	8/ 1/74	A-23	703LBI	1974	CHEVROLET	GOOD	NO	100	94	0.30	-0.04	72	78	17.0	1.460	5.07
EXXON	8/ 1/74	A-24	VLM962	1968	DODGE	POOR	NO	100	104	0.00	-0.09	73	75	5.4	1.020	4.50
EXXON	8/ 1/74	A-25	611AZR	1970	AMER MOTOR	GOOD	NO	100	87	0.00	-0.02	73	0	7.1	0.330	4.58
EXXON	8/ 1/74	A-26	402GLD	1973	CHEVROLET	GOOD	NO	0	83	0.55	0.02	76	78	9.0	1.000	4.91
EXXON	8/ 1/74	A-27	775B6S	1974	CHEVROLET	POOR	NO	100	86	0.00	-0.02	73	75	14.3	0.020	4.61
EXXON	8/ 1/74	A-28	65044N	1973	JEEP	GOOD	NO	0	0	0.00	0.02	73	78	14.4	1.720	4.17
EXXON	8/ 1/74	A-29	UB33800;3	1966	RD	GOOD	NO	40	81	0.00	0.09	73	74	5.4	1.010	4.05
EXXON	8/ 1/74	A-30	617HKS	1973	MERCURY	GOOD	NO	0	84	0.45	-0.08	71	76	10.7	1.320	4.49
EXXON	8/ 1/74	A-31	310KOG	1974	DODGE	GOOD	NO	0	84	0.00	-0.01	72	75	7.2	0.630	-1.00

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LICENSE    VAPOR  DELTA  VEHICLE            SAT    BASE     ACT      AMT     HC %     HC
           LIQUID TEMP   DESIGNATION         HC     RET     RET       HC     RECV   EMISS
            RATIO                          CONC      HC      HC     LOST     BASE  GM/GAL
77002C       0.00    -3 REGULAR            39.8    75.1     0.3     74.7      0.4   4.642
0720452      0.94     4 BASELINE           38.1    22.3    21.9      0.4     98.0   0.082
VJL292       0.81    15 REGULAR            39.8    61.8    63.1     -1.3    102.1  -0.072
588DRN       1.05     4 BASELINE           39.8    22.7    24.8     -2.2    109.5  -0.401
199KNZ       1.22     3 REGULAR            39.8    23.0    28.8     -5.7    124.9  -1.061
393GTA       1.09     1 FORCE FIT          39.8    23.7    25.8     -2.1    108.7  -0.384
10527V       0.91    11 FORCE FIT          37.8    19.2    20.5     -1.3    106.9  -0.246
TF328     -209.34     4 BAD READING        38.5    21.9-4777.6   4799.5*-21783888.793
BYN287       0.94    -3 REGULAR            40.4    43.6    38.5      5.1     88.4   0.550
ZET165       0.47     9 FORCE FIT          39.1    20.5    10.9      9.6     53.2   1.780
223YYJ       0.00     9 FORCE FIT          39.8    20.9     0.0     20.9      0.0   3.868
26888S       1.01     6 REGULAR            37.8    20.9    22.7     -1.8    108.6  -0.335
12169M       0.67     0 REGULAR            37.8    23.4    15.2      8.1     65.2   1.476
379GFE       1.05    11 REGULAR            39.1    33.1    40.5     -7.4    122.5  -0.826
624LBF       0.74    23 REGULAR            40.4    33.8    37.2     -3.4    110.1  -0.303
407EDD       0.11    30 REGULAR            39.8    13.4     2.6     10.8     19.5   1.994
880KDY       1.11     1 BASELINE           39.8    32.1    35.3     -3.2    110.0  -0.438
97490W       0.07    12 REGULAR            40.4    77.6     7.3     70.3      9.4   3.379
UCW618       0.25    32 REGULAR            41.1    25.9    12.2     13.8     46.9   1.288
023HKK       0.62   -75 BAD READING        42.5   207.5    59.7    147.8     28.8   7.175
CHW-632      0.12    12 REGULAR            41.1    35.7     5.1     30.6     14.2   3.254
24583R       1.05   -73 BAD READING        40.4    85.0    41.9     43.2     49.2   4.798
BSA114       1.34     8 REGULAR            42.5    22.7    33.9    -11.2    149.2  -2.069
UBW517       0.34     4 BASELINE           41.1    41.7    14.5     27.1     34.9   2.827
665CLY       0.56    18 REGULAR            42.5    25.2    18.9      6.3     74.9   0.878
TLZ-429      0.25    20 REGULAR            43.2    18.4     6.4     12.0     34.7   2.228
787DGJ       0.65    22 REGULAR            40.4    46.5    43.9      2.6     94.4   0.172
ABY947       0.59     4 REGULAR            11.4     6.8     4.1      2.6     61.2   0.469
703LBI       0.64    22 FORCE FIT          41.8    53.7    50.1      3.6     93.3   0.211
VLM962       1.41    31 REGULAR            39.8    13.0    33.3    -20.3    255.9  -3.761
611AZR       0.35    14 FORCE FIT          11.4     7.2     3.1      4.1     42.9   0.581
402GLD       0.83     7 BASELINE           41.8    37.8    34.3      3.5     90.8   0.388
77586S       0.01    13 REGULAR            39.8    51.5     0.7     50.9      1.3   3.557
65044N       0.89   -73 BAD READING        41.8   140.7    59.1     81.6     42.0   5.666
U83380#3     1.40     8 REGULAR            39.1    20.9    32.5    -11.6    155.4  -2.143
617HKS       0.92    13 BASELINE           40.4    39.2    43.9     -4.7    111.9  -0.436
310KDG       0.65    12 REGULAR            39.8    26.4    20.6      5.8     77.9   0.810
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	8/ 1/74	A-32	33624P	1973	CHEVROLET	GOOD	NO	0	83	0.00	-0.01	74	76	9.0	1.000	4.62
EXXON	8/ 1/74	A-33	576FXO	1972	DATSUN	POOR	NO	100	88	0.00	-0.01	72	75	5.4	0.320	5.40
EXXON	8/ 1/74	A-34	206DEM	1971	PLYMOUTH	GOOD	NO	0	79	0.00	0.03	73	75	5.4	0.800	4.76
EXXON	8/ 1/74	A-35	YJR510	1969	CHEVROLET	GOOD	NO	0	92	0.00	-0.01	71	75	9.0	0.790	6.67
EXXON	8/ 1/74	A-36	244GOE	1968	FORD	GOOD	NO	0	85	0.00	-0.01	73	75	5.4	0.600	5.59
EXXON	8/ 1/74	A-37	ZIC002	1969	CHEVROLET	GOOD	NO	15	95	0.00	-0.02	72	75	5.9	0.290	4.66
EXXON	8/ 1/74	A-38	SPR573	1966	PLYMOUTH	GOOD	NO	100	75	0.00	-0.08	71	74	14.6	0.920	5.21
EXXON	8/ 1/74	A-39	XJX-438	1969	FORD	POOR	NO	100	88	0.00	-0.02	72	73	13.9	1.020	4.93
EXXON	8/ 1/74	B- 1	216EDV	1972	DODGE	GOOD	NO	100	79	0.00	-0.10	74	75	5.4	0.560	4.63
EXXON	8/ 1/74	B- 2	UAH682	1967	VOLKSWAGON	GOOD	NO	60	75	0.00	-0.06	74	75	5.4	0.670	4.84
EXXON	8/ 1/74	B- 3	276FIV	1972	VOLVO	GOOD	NO	100	78	0.00	-0.06	75	76	5.4	0.570	4.63
EXXON	8/ 1/74	B- 4	199KNZ	19 0	VOLKSWAGON	GOOD	NO	0	75	0.00	-0.10	74	76	5.4	0.760	4.70
EXXON	8/ 1/74	B- 5	617HKS	1973	MERCURY	GOOD	NO	0	84	0.00	-0.16	75	75	18.6	2.570	4.57
EXXON	8/ 1/74	B- 6	999KTP	1974	FORD	GOOD	NO	0	82	0.00	-0.08	75	75	5.4	0.900	5.14
EXXON	8/ 1/74	B- 7	571GJW	1973	CHEVROLET	GOOD	NO	0	86	0.00	-0.18	75	75	14.1	1.700	9.10
EXXON	8/ 1/74	B- 8	003JKV	1973	AMC	GOOD	NO	100	83	0.00	-0.18	75	75	4.5	0.370	6.00
EXXON	8/ 1/74	B- 9	030014	1967	CHEVROLET	GOOD	NO	5	81	0.00	-0.18	75	80	5.4	0.480	4.76
EXXON	8/ 1/74	B-10	UAA970	1967	FORD	GOOD	NO	100	71	0.00	-0.20	75	75	5.4	0.500	4.76
EXXON	8/ 1/74	B-11	070AWY	1962	MERCURY	GOOD	NO	0	81	0.00	-0.17	75	75	5.4	0.710	4.98
EXXON	8/ 1/74	B-12	377LDG	1974	PONTIAC	GOOD	NO	0	97	0.00	-0.20	75	85	15.0	1.600	4.61
EXXON	8/ 1/74	B-13	CCN186	1963	FORD	GOOD	YES	100	90	0.00	-0.02	75	85	12.3	0.850	-1.00
EXXON	8/ 1/74	B-14	T64010	1965	FORD	GOOD	NO	100	86	0.00	-0.04	75	85	5.4	0.100	3.40
EXXON	8/ 1/74	B-15	27629W	1967	FORD	GOOD	NO	0	92	0.00	-0.16	76	86	5.4	0.220	4.63
EXXON	8/ 1/74	B-16	690JTC	1974	GMC	GOOD	NO	10	86	0.00	0.40	75	85	5.4	1.000	4.91
EXXON	8/ 1/74	B-17	042DGZ	1960	PONTIAC	GOOD	NO	100	86	0.00	-0.06	75	85	16.4	1.740	4.53
EXXON	8/ 1/74	B-18	994FIW	1972	BUICK	GOOD	NO	0	96	0.00	-0.06	75	85	17.4	1.700	4.72
EXXON	8/ 1/74	B-19	BZU648	1964	FORD	GOOD	NO	100	92	0.00	-0.04	75	85	5.4	0.120	4.76
EXXON	8/ 1/74	B-20	960KDV	1974	DODGE	GOOD	NO	0	86	0.00	-0.08	75	85	5.4	0.670	4.63
EXXON	8/ 1/74	B-21	10870V	1961	CHEVROLET	GOOD	NO	0	86	0.00	0.02	78	85	5.4	0.730	4.70
EXXON	8/ 1/74	B-22	102GOC	1973	FORD	GOOD	NO	0	85	0.52	-0.06	78	85	5.4	0.500	4.98
EXXON	8/ 1/74	B-23	388F2S	1970	DATSUN	GOOD	NO	10	86	0.00	-0.08	77	85	7.7	0.000	-1.00
EXXON	8/ 1/74	B-24	WRT174	1968	CHEVROLET	GOOD	NO	0	90	0.00	-0.10	75	85	5.4	0.440	4.70
EXXON	8/ 1/74	B-25	466AWT	1970	CHEVROLET	GOOD	NO	100	90	0.00	-0.02	75	85	5.4	0.000	4.58
EXXON	8/ 1/74	B-26	DKJ506	1963	CHEVROLET	GOOD	NO	10	84	0.00	-0.04	76	85	11.0	1.010	4.49
EXXON	8/ 1/74	B-27	VXE295	1968	DODGE	POOR	NO	100	86	0.00	-0.04	75	85	5.4	0.360	4.70
EXXON	8/ 1/74	B-28	DYZ021	1961	MERCEDES	GOOD	NO	10	88	0.00	-0.06	75	84	8.9	1.090	7.85
EXXON	8/ 1/74	B-29	137FSM	1972	BUICK	GOOD	NO	100	103	0.50	-0.01	75	85	8.9	0.280	7.85

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LICENSE    VAPOR  DELTA  VEHICLE              SAT    BASE     ACT     AMT    HC %      HC
          LIQUID  TEMP   DESIGNATION           HC     RET     RET      HC    RECV   EMISS
           RATIO                             CONC      HC      HC    LOST    BASE  GM/GAL
33624P      0.83      9 REGULAR              40.4    35.4    33.2     2.2    93.9   0.241
576FXO      0.44     16 REGULAR              39.8    18.4    10.5     7.9    56.9   1.468
206DEM      1.11      6 REGULAR              39.8    22.0    26.1    -4.2   119.1  -0.775
YJR510      0.66     21 BASELINE             39.8    27.7    25.8     1.8    93.3   0.205
244GQE      0.83     12 BASELINE             39.8    19.8    19.6     0.2    99.0   0.038
ZIC002      0.37     23 REGULAR              39.8    17.4     9.5     7.9    54.6   1.335
SPR573      0.47      4 REGULAR              39.1    60.3    29.6    30.7    49.0   2.104
XJX-438     0.55     16 REGULAR              38.5    45.8    32.2    13.5    70.4   0.974
216EDV      0.78      5 REGULAR              39.8    22.3    18.3     4.0    82.0   0.743
UAH682      0.93      1 REGULAR              39.8    23.7    21.9     1.8    92.2   0.342
276FIV      0.79      3 REGULAR              40.4    23.4    18.9     4.5    80.9   0.829
199KNZ      1.05      1 FORCE FIT            40.4    24.1    25.3    -1.1   104.6  -0.206
617HKS      1.03      9 BASELINE             39.8    71.9    84.0   -12.0   116.7  -0.648
999KTP      1.37      7 BASELINE             39.8    21.6    32.4   -10.8   149.8  -1.991
571GJW      0.90     11 BASELINE             39.8    52.7    55.6    -2.9   105.5  -0.205
003JKV      0.62      8 REGULAR              39.8    17.7    12.1     5.6    68.3   1.247
Q30014      0.66      6 FORCE FIT            43.2    23.9    17.0     6.8    71.4   1.262
UAA970      0.69     -4 REGULAR              39.8    25.5    16.3     9.2    64.0   1.702
070AWY      0.98      6 BASELINE             39.8    22.0    23.2    -1.2   105.7  -0.231
377LDG      0.80     22 BASELINE             46.9    55.4    64.0    -8.7   115.6  -0.555
CCN186      0.52     15 REGULAR              46.9    50.4    32.8    17.6    65.1   1.431
T64010      0.14     11 REGULAR              46.9    23.8     3.9    20.0    16.2   3.696
27629W      0.30     16 FORCE FIT            47.7    22.1     8.6    13.4    39.1   2.489
690JTC      2.49     11 REGULAR              46.9    23.8    69.4   -45.6   291.6  -8.451
042DGZ      0.79     11 REGULAR              46.9    72.3    67.1     5.2    92.8   0.317
994FIW      0.77     21 FORCE FIT            46.9    63.1    68.7    -5.5   108.8  -0.318
8ZU648      0.17     17 FORCE FIT            46.9    21.3     4.6    16.7    21.8   3.084
960KDV      0.93     11 BASELINE             46.9    23.8    25.9    -2.0   108.5  -0.377
10870V      1.01      8 BASELINE             46.9    25.1    28.2    -3.1   112.3  -0.571
102GQC      0.69      7 BASELINE             46.9    25.5    19.3     6.2    75.6   1.150
38852S      0.85      9 REGULAR              46.9    35.2    34.0     1.2    96.6   0.157
WRT174      0.61     15 REGULAR              46.9    22.1    17.0     5.2    76.7   0.954
466AWT      0.00     15 BAD READING          46.9    22.1     0.0    22.1     0.0   4.098
DKJ506      0.69      8 REGULAR              46.9    51.1    39.0    12.1    76.3   1.102
VXE295      0.50     11 REGULAR              46.9    23.8    13.9     9.9    58.3   1.838
DYZ021      0.92     13 REGULAR              46.2    37.2    41.4    -4.1   111.1  -0.464
137FSM      0.24     28 FORCE FIT            46.9    27.4    10.8    16.6    39.4   1.868
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	8/ 1/74	B-30	CNZ966	1965	PONTIAC	POOR	NO	100	85	0.00	-0.10	75	84	5.4	0.010	7.53
EXXON	8/ 1/74	B-31	0720452	1974	GMC	GOOD	NO	0	0	1.20	-0.01	75	85	5.4	0.480	4.63
EXXON	8/ 1/74	B-32	OLA191	1964	VOLKSWAGON	GOOD	NO	0	80	0.00	-0.04	75	83	5.4	0.740	4.98
EXXON	8/ 1/74	B-33	8IZ484	1955	CHEVROLET	GOOD	NO	100	81	0.00	0.10	75	84	8.9	0.610	7.85
EXXON	8/ 1/74	B-34	411CPL	1970	FORD	GOOD	NO	0	86	1.40	-0.08	75	80	5.4	0.660	5.68
EXXON	8/ 1/74	B-35	63197V	1974	FORD	GOOD	NO	100	81	0.00	-0.10	75	80	8.9	0.760	9.37
EXXON	8/ 1/74	B-36	251CMO	1971	MERCURY	GOOD	NO	100	85	0.54	0.04	75	83	5.4	0.620	4.98
EXXON	8/ 1/74	B-37	30111L	1972	CHEVROLET	GOOD	NO	25	78	0.49	-0.04	75	83	5.4	0.590	4.63
EXXON	8/ 1/74	B-38	973GUX	1974	OLDSMOBILE	GOOD	NO	0	85	0.52	-0.08	75	82	10.4	0.970	5.11
EXXON	8/ 1/74	B-39	980RYX	1968	FORD	GOOD	NO	80	82	0.00	-0.04	75	80	12.5	1.760	4.55
EXXON	8/ 1/74	B-40	133FVD	1972	PLYMOUTH	GOOD	NO	0	81	0.00	-0.04	75	80	5.4	0.570	-1.00
EXXON	8/ 1/74	B-41	919JTT	1973	CHEVROLET	GOOD	NO	0	75	5.00	-0.20	75	83	8.9	1.100	-1.00
EXXON	8/ 1/74	B-42	567FHB	1972	DODGE	GOOD	NO	0	82	0.55	-0.10	75	82	5.4	0.680	5.06
EXXON	8/ 1/74	B-43	481FRN	1971	CHEVROLET	GOOD	NO	0	82	0.29	-0.10	74	74	7.2	0.750	4.75
EXXON	8/ 1/74	B-44	DKL015	1964	FORD	POOR	NO	100	78	0.00	-0.01	74	73	5.4	0.270	4.44
EXXON	8/ 1/74	B-45	BHW810	1969	TOYOTA	GOOD	NO	0	74	0.00	0.02	74	74	10.1	1.420	4.63
EXXON	8/ 1/74	B-46	DKZ207	1965	DODGE	POOR	NO	100	79	0.00	0.04	74	70	8.9	0.900	4.56
EXXON	8/ 2/74	A- 1	420LBJ	1974	DODGE	GOOD	NO	0	75	0.39	0.03	68	59	5.4	0.740	5.31
EXXON	8/ 2/74	A- 2	G1149367	1971	FORD	GOOD	NO	0	66	1.10	0.07	72	61	5.4	0.780	4.91
EXXON	8/ 2/74	A- 3	3654L	1972	CHEVROLET	GOOD	NO	100	0	0.00	0.03	72	63	17.7	2.290	4.70
EXXON	8/ 2/74	A- 4	25233P	1973	CHEVROLET	GOOD	NO	5	72	0.20	0.04	72	63	5.4	0.710	5.14
EXXON	8/ 2/74	A- 5	WGP459	1968	PONTIAC	GOOD	NO	100	66	0.00	0.08	73	63	5.4	0.860	4.78
EXXON	8/ 2/74	A- 6	386FRN	1972	CHEVROLET	GOOD	NO	0	67	1.00	0.06	73	64	5.4	0.720	5.49
EXXON	8/ 2/74	A- 7	+30014	1967	CHEVROLET	GOOD	NO	100	65	0.00	0.08	73	63	5.4	0.780	4.63
EXXON	8/ 2/74	A- 8	110CVH	1970	FORD	GOOD	YES	100	67	0.00	0.04	73	64	8.6	0.490	2.98
EXXON	8/ 2/74	A- 9	69483V	1972	DATSUN	GOOD	NO	0	68	0.00	0.10	70	60	7.1	0.880	3.94
EXXON	8/ 2/74	A-10	459RIM	1970	CHEVROLET	GOOD	NO	0	70	1.50	0.14	73	65	13.8	1.800	4.65
EXXON	8/ 2/74	A-11	33099R	1973	DODGE	GOOD	NO	0	67	5.00	0.38	73	64	7.2	1.840	4.45
EXXON	8/ 2/74	A-12	469KNW	1974	DODGE	GOOD	NO	0	69	0.00	-0.08	74	65	10.1	1.410	4.56
EXXON	8/ 2/74	A-13	RNV575	1966	VOLKSWAGON	POOR	NO	100	62	0.00	-0.06	74	63	5.4	0.070	7.04
EXXON	8/ 2/74	A-14	270GVC	1973	FORD	GOOD	NO	0	66	5.00	0.10	75	65	10.7	1.540	6.55
EXXON	8/ 2/74	A-15	545DOZ	1967	CHEVROLET	GOOD	NO	100	63	0.00	0.02	73	64	5.4	0.190	6.48
EXXON	8/ 2/74	A-16	R214	1968	FORD	GOOD	NO	100	70	0.00	0.10	74	63	5.4	0.530	4.63
EXXON	8/ 2/74	A-17	APF672	1955	DODGE	GOOD	NO	100	68	0.00	0.12	73	63	13.7	1.410	4.54
EXXON	8/ 2/74	A-18	57294L	1972	CHEVROLET	POOR	NO	100	68	0.00	-0.10	75	63	5.4	0.020	7.20
EXXON	8/ 2/74	A-19	MJC109	1964	PLYMOUTH	GOOD	NO	0	66	0.00	-0.02	74	64	11.5	1.340	5.81
EXXON	8/ 2/74	A-20	298CSQ	1970	FORD	GOOD	NO	100	75	0.00	0.10	75	66	16.0	1.710	12.97

LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
CNZ966	0.01	10	REGULAR	46.2	23.8	0.4	23.5	1.6	4.344
0720452	0.66	-75	BAD READING	46.9	60.1	18.5	41.6	30.8	7.699
OLA191	1.03	5	BASELINE	45.4	25.5	27.6	-2.1	108.4	-0.395
BIZ484	0.51	6	REGULAR	46.2	42.0	23.1	18.9	55.1	2.121
411CPL	0.91	11	BASELINE	43.2	21.9	23.4	-1.5	106.9	-0.281
63197V	0.64	6	REGULAR	43.2	39.3	27.0	12.3	68.6	1.386
251CMD	0.86	10	FORCE FIT	45.4	23.4	23.1	0.3	98.7	0.056
30111L	0.82	3	FORCE FIT	45.4	26.3	22.0	4.3	83.7	0.793
973GUX	0.70	10	BASELINE	44.7	44.4	35.6	8.8	80.2	0.846
980BYX	1.05	7	REGULAR	43.2	54.3	62.5	-8.2	115.0	-0.653
133EVQ	0.79	6	BASELINE	43.2	23.9	20.2	3.6	84.8	0.670
919JTT	0.92	0	FORCE FIT	45.4	45.4	41.1	4.3	90.5	0.485
567FHB	0.94	7	BASELINE	44.7	24.3	25.0	-0.7	102.9	-0.129
481FRN	0.78	8	BASELINE	39.1	27.9	24.1	3.8	86.5	0.521
DKL015	0.37	4	REGULAR	38.5	21.9	8.5	13.4	38.9	2.481
BHW810	1.05	0	BASELINE	39.1	44.3	45.6	-1.3	102.9	-0.129
DKZ207	0.76	5	REGULAR	36.6	33.8	27.1	6.8	80.0	0.762
420LBJ	1.03	7	BASELINE	30.5	16.6	18.5	-2.0	112.0	-0.367
G1149367	1.08	-6	BASELINE	31.5	20.8	20.2	0.6	97.1	0.111
3654L	0.97	-72	BAD READING	32.6	133.8	61.3	72.5	45.8	4.097
25233P	0.98	0	FORCE FIT	32.6	19.7	19.0	0.7	96.3	0.136
WGP459	1.19	-7	REGULAR	32.6	21.8	23.0	-1.2	105.6	-0.228
386ERN	1.00	-6	BASELINE	33.1	21.9	19.6	2.3	89.7	0.419
+30014	1.08	-8	REGULAR	32.6	22.1	20.9	1.2	94.5	0.223
110CVH	0.43	-6	REGULAR	33.1	34.8	13.3	21.5	38.3	2.498
09483V	0.93	-2	REGULAR	31.0	25.4	22.4	3.0	88.1	0.425
459BIM	0.98	-3	BASELINE	33.7	54.5	49.8	4.7	91.4	0.338
33099R	1.91	-6	BASELINE	33.1	29.2	50.1	-20.9	171.8	-2.908
469KNW	1.04	-5	REGULAR	33.7	41.0	39.0	2.0	95.2	0.196
RNV575	0.09	-12	REGULAR	32.6	23.3	1.9	21.4	8.1	3.960
270GVC	1.08	-9	BASELINE	33.7	45.8	42.6	3.2	93.0	0.301
545DOZ	0.26	-10	REGULAR	33.1	23.1	5.2	17.9	22.4	3.312
R214	0.73	-4	REGULAR	32.6	20.9	14.2	6.7	67.8	1.246
APF672	0.77	-5	REGULAR	32.6	53.8	37.8	16.1	70.2	1.172
57294L	0.03	-7	REGULAR	32.6	21.8	0.5	21.3	2.5	3.937
MJC109	0.87	-6	FORCE FIT	33.1	46.6	36.5	10.1	78.3	0.877
298CSQ	0.80	0	REGULAR	34.2	61.5	48.1	13.4	78.3	0.836

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
EXXON	8/ 2/74	A-21	KZK685	1957	CHEVROLET	POOR	NO	100	73	0.00	0.10	75	65	8.9	0.410	6.75
EXXON	8/ 2/74	A-22	166GFD	1973	FORD	GOOD	NO	100	70	0.00	0.08	73	65	9.5	1.300	4.71
EXXON	8/ 2/74	A-23	RLY589	1936	FORD	GOOD	NO	0	72	0.00	0.14	73	67	5.4	0.670	5.23
EXXON	8/ 2/74	A-24	1068953	1974	VOLKSWAGON	POOR	NO	100	76	0.00	-0.05	73	68	8.0	0.720	4.32
EXXON	8/ 2/74	A-25	3BYM	1970	PLYMOUTH	GOOD	NO	0	72	0.00	0.06	74	68	14.9	1.560	4.63
EXXON	8/ 2/74	A-26	690JTC	1974	GMC	GOOD	NO	100	77	0.20	0.38	73	78	5.4	0.860	5.14
EXXON	8/ 2/74	A-27	393GTA	1973	FORD	GOOD	NO	100	75	0.00	0.44	72	68	7.1	0.760	9.47
EXXON	8/ 2/74	A-28	YIN878	1965	CHEVROLET	GOOD	NO	100	78	0.00	0.16	73	69	9.0	0.690	9.31
EXXON	8/ 2/74	A-29	7ERZ	1968	FORD	GOOD	NO	100	88	0.00	-0.20	74	71	10.7	1.080	8.79
EXXON	8/ 2/74	A-30	063GTS	1973	DODGE	GOOD	NO	100	78	0.00	0.05	72	70	4.5	0.570	4.58
EXXON	8/ 2/74	A-31	TTA688	1956	CHEVROLET	GOOD	NO	100	72	0.00	-0.03	72	70	5.4	0.020	4.21
EXXON	8/ 2/74	A-32	WNK827	1964	PLYMOUTH	POOR	NO	100	73	0.00	0.12	72	69	7.1	0.270	5.76
EXXON	8/ 2/74	A-33	SOU351	1962	CHEVROLET	GOOD	NO	100	66	0.00	0.16	73	65	9.5	0.170	4.22
EXXON	8/ 2/74	A-34	9KTP	1974	FORD	GOOD	NO	100	80	0.00	-0.16	73	70	8.2	0.840	6.00
EXXON	8/ 2/74	A-35	36013W	1974	GMC	GOOD	NO	100	85	0.00	-0.06	74	70	7.2	0.640	9.19

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LICENSE    VAPOR  DELTA  VEHICLE                SAT    BASE     ACT     AMT    HC %      HC
           LIQUID TEMP   DESIGNATION             HC     RET     RET      HC    RECV   EMISS
           RATIO                                CONC     HC      HC    LOST    BASE  GM/GAL
KZK685      0.34     -2 REGULAR                 33.7   34.6    11.3    23.3    32.8   2.617
166GFD      1.02     -3 REGULAR                 33.7   37.5    36.0     1.5    95.9   0.161
RLY589      0.93     -1 REGULAR                 34.8   21.4    19.2     2.2    89.5   0.416
1068953     0.57      3 REGULAR                 35.4   30.4    20.9     9.4    69.0   1.178
3BYM        0.78     -2 REGULAR                 35.4   61.0    45.4    15.6    74.5   1.045
690JTC      1.19      4 FORCE FIT               41.8   23.8    29.5    -5.7   124.0  -1.057
393GTA      0.80      3 REGULAR                 35.4   27.0    22.1     4.8    82.0   0.683
YIN878      0.57      5 REGULAR                 36.0   33.7    20.4    13.3    60.6   1.473
7ERZ        0.75     14 REGULAR                 37.2   35.4    33.0     2.4    93.3   0.223
063GTS      0.95      6 REGULAR                 36.6   16.8    17.1    -0.3   101.8  -0.067
TTA688      0.03      0 REGULAR                 36.6   22.2     0.6    21.6     2.7   3.996
WNK827      0.28      1 REGULAR                 36.0   28.3     8.0    20.3    28.3   2.855
SOU351      0.13     -7 REGULAR                 33.7   39.6     4.7    34.9    11.9   3.677
9KTP        0.77      7 REGULAR                 35.6   30.2    25.3     4.9    83.7   0.600
36013W      0.66     11 REGULAR                 36.6   24.8    19.2     5.5    77.8   0.764
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 5/74	A- 1	04427U	1974	FORD	GOOD	YES	20	87	0.00	-0.20	83	84	9.1	1.050	3.31
STANDARD	8/ 5/74	A- 2	548FCF	1964	VOLKSWAGON	GOOD	NO	100	95	0.00	0.10	85	84	6.7	0.860	-1.00
STANDARD	8/ 5/74	A- 3	G1150491	19 0	AM	GOOD	NO	60	95	0.00	0.00	84	84	5.5	0.610	5.24
~~EXXON~~STD	8/ 5/74	A- 4	504EFZ	1972	FORD	GOOD	NO	100	89	0.00	0.00	84	84	12.3	1.300	4.24
STANDARD	8/ 5/74	A- 5	774EZO	1971	DODGE	GOOD	NO	0	106	0.00	-0.20	85	83	14.0	1.000	4.31
STANDARD	8/ 5/74	A- 6	37063C	1972	FORD	GOOD	NO	100	95	0.00	-0.10	83	85	9.1	0.680	4.59
STANDARD	8/ 5/74	A- 7	SLY506	1966	FORD	GOOD	NO	100	102	0.00	-0.20	85	87	12.3	0.990	4.27
STANDARD	8/ 5/74	A- 8	326JWD	1974	PONTIAC	GOOD	NO	0	104	1.40	-0.20	83	87	19.4	2.020	9.86
STANDARD	8/ 5/74	A- 9	477KUL	1974	7ERCEDES	GOOD	NO	100	107	0.00	-0.10	83	87	12.9	1.000	4.32
STANDARD	8/ 5/74	A-10	587JAW	1973	GMC	GOOD	NO	100	94	2.20	0.10	85	90	17.6	1.910	4.22
STANDARD	8/ 5/74	A-11	RLH603	1966	CHEVROLET	GOOD	NO	60	91	0.00	0.10	85	90	12.0	1.320	4.29
STANDARD	8/ 5/74	A-12	119CGM	1971	CHEVROLET	GOOD	NO	30	103	0.30	-0.01	85	92	15.1	1.430	4.31
STANDARD	8/ 5/74	A-13	095BGM	1970	FORD	GOOD	NO	100	92	0.00	-0.10	85	93	10.3	1.310	4.18
STANDARD	0/ 0/74	A-14	29	1964	PLYMOUTH	GOOD	NO	100	94	0.00	0.04	92	95	14.0	1.720	4.00
STANDARD	8/ 5/74	A-15	L577	1966	PLYMOUTH	GOOD	NO	100	96	0.00	0.06	85	92	7.3	0.650	4.38
STANDARD	8/ 5/74	A-16	831960	1973	DODGE	GOOD	NO	40	115	-0.20	-0.05	84	93	15.8	0.880	4.37
STANDARD	8/ 5/74	A-18	F083	1967	FORD	GOOD	NO	80	107	0.00	-0.30	86	93	12.3	1.290	4.39
STANDARD	8/ 5/74	A-19	XOK720	1969	VOLKSWAGON	POOR	NO	100	94	0.00	0.05	86	93	0.5	0.020	5.60
STANDARD	8/ 5/74	A-20	GJD786	1972	VOLKSWAGON	GOOD	NO	100	90	0.00	-0.05	85	93	0.7	0.070	4.28
STANDARD	8/ 5/74	B- 1	363GCN	1974	CHEVROLET	GOOD	NO	0	84	0.00	0.02	84	93	12.0	1.006	6.28
STANDARD	8/ 5/74	B- 2	9KTP	1974	FORD	GOOD	NO	0	89	0.00	0.08	84	93	5.0	0.575	5.26
STANDARD	8/ 5/74	B- 3	617HKS	1973	MERC	GOOD	NO	100	84	0.00	-0.06	84	92	7.2	0.857	6.75
STANDARD	8/ 5/74	B- 4	199ARF	1970	FORD	GOOD	NO	10	98	-0.10	-0.14	86	92	11.0	0.676	5.20
STANDARD	8/ 5/74	B- 5	963BVJ	1971	CHEVROLET	GOOD	NO	0	102	0.00	-0.12	86	94	10.4	0.893	5.24
STANDARD	8/ 5/74	B- 6	BF402	1965	CHEVROLET	POOR	NO	100	76	0.00	0.02	84	102	11.7	1.476	5.75
STANDARD	8/ 5/74	B- 7	DELTA1	1973	CADILLAC	GOOD	NO	0	103	0.00	-0.08	84	97	23.0	1.623	6.03
STANDARD	8/ 5/74	B- 8	905BVN	1970	TOYOTA	POOR	YES	100	94	0.00	-0.06	84	94	7.7	0.843	5.85
STANDARD	8/ 5/74	B- 9	601KUL	1974	CHEVROLET	GOOD	NO	100	100	0.00	-0.04	84	99	10.2	0.365	7.29
STANDARD	8/ 5/74	B-10	60350M	1973	CHEVROLET	GOOD	NO	0	94	0.00	-0.10	84	102	15.0	1.957	5.56
STANDARD	8/ 5/74	B-11	528JYP	1974	DODGE	GOOD	NO	0	107	0.00	-0.16	84	100	4.6	0.312	5.82
STANDARD	8/ 5/74	B-12	087FHT	1972	BUICK	GOOD	NO	0	105	0.15	-0.14	84	103	7.8	0.678	5.26
STANDARD	8/ 5/74	B-13	3979	1961	CHEVROLET	GOOD	NO	20	87	0.00	-0.12	84	105	12.5	1.605	5.60
STANDARD	8/ 5/74	B-14	387ALL	1970	VOLKSWAGON	GOOD	NO	100	88	0.00	-0.06	82	90	8.4	1.061	5.25
STANDARD	8/ 5/74	B-15	9EDM	1972	CHEVROLET	GOOD	NO	0	101	0.00	-0.22	82	91	7.1	0.704	5.33
STANDARD	8/ 5/74	B-16	056HXM	1973	OLDSMOBILE	GOOD	NO	0	119	0.00	-0.20	85	95	18.6	0.705	5.31
STANDARD	8/ 5/74	B-17	052FQV	1972	DODGE	POOR	NO	0	0	0.00	-0.02	83	93	10.1	1.080	5.30
STANDARD	8/ 5/74	B-18	250EDO	1972	DODGE	GOOD	NO	100	96	2.50	-0.04	88	93	11.7	1.172	5.16

LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
04427U	0,86	4	REGULAR	46,2	40,5	39,8	0,7	98,4	0,072
548FCF	0,96	10	FORCE FIT	46,2	26,3	32,6	-6,4	124,3	-0,951
01150491	0,83	11	REGULAR	46,2	21,1	23,1	-2,1	109,9	-0,378
504EFZ	0,84	5	REGULAR	46,2	53,7	52,4	1,3	97,6	0,105
774EZO	0,51	21	REGULAR	45,4	42,9	37,3	5,5	87,1	0,374
37063C	0,56	12	FORCE FIT	46,9	34,6	26,2	8,4	75,8	0,922
SLY586	0,60	17	REGULAR	48,5	42,6	39,5	3,2	92,6	0,257
326JWD	0,78	21	BASELINE	48,5	60,0	80,6	-20,5	134,2	-1,658
477KUL	0,50	24	REGULAR	48,5	36,3	39,9	-3,6	109,8	-0,277
587JAN	0,81	9	FORCE FIT	51,0	77,9	80,1	-2,1	102,7	-0,122
RLH003	0,82	6	REGULAR	51,0	56,7	55,3	1,3	97,7	0,110
119CGM	0,71	18	FORCE FIT	52,7	55,4	62,0	-6,6	111,9	-0,438
0958GM	0,95	7	REGULAR	53,6	50,1	57,7	-7,7	115,3	-0,744
29	0,92	2	REGULAR	55,4	77,8	78,3	-0,6	100,7	-0,040
L577	0,67	11	REGULAR	52,7	31,9	28,2	3,8	88,2	0,518
831968	0,42	31	FORCE FIT	53,6	37,8	38,8	-1,0	102,7	-0,084
F083	0,78	21	FORCE FIT	53,6	42,0	56,8	-14,8	135,2	-1,203
XGK728	0,55	8	REGULAR	53,6	40,4	27,3	13,1	67,6	1,544
6JD786	0,86	5	REGULAR	53,6	44,1	3,1	41,0	7,0	4,711
363GCN	0,68	0	REGULAR	53,6	67,0	47,9	19,1	71,5	1,593
9KTP	0,86	5	BASELINE	53,6	25,3	25,3	-0,0	100,0	-0,002
617HKS	0,89	0	REGULAR	52,7	39,5	37,1	2,4	94,0	0,330
199ARF	0,46	12	FORCE FIT	52,7	47,0	29,3	17,7	62,3	1,810
963BVJ	0,64	16	REGULAR	54,5	41,6	40,0	1,6	96,2	0,152
0F4028	0,94	-8	REGULAR	62,2	87,0	75,5	11,5	86,8	0,801
DELTA1	0,53	19	REGULAR	57,3	89,1	76,4	12,7	85,8	0,551
905BVW	0,84	10	FORCE FIT	54,5	35,6	1,9	33,7	5,4	4,377
001KUL	0,27	16	REGULAR	59,2	44,3	17,8	26,6	40,1	2,603
00350M	0,98	10	BASELINE	62,2	79,3	100,1	-20,9	126,3	-1,391
520JYP	0,51	23	REGULAR	60,2	16,6	15,4	1,2	93,0	0,252
087FMT	0,65	21	BASELINE	63,3	31,5	35,3	-3,8	112,0	-0,486
3970	0,96	3	REGULAR	68,4	80,4	86,3	-5,9	107,3	-0,471
387ALL	0,94	6	REGULAR	51,0	39,7	44,5	-4,8	112,1	-0,574
9EDM	0,74	19	REGULAR	51,9	24,9	30,0	-5,1	120,5	-0,720
056HXM	0,28	34	BASELINE	55,4	40,0	32,1	7,9	80,3	0,424
052FGV	0,80	-83	BAD READING	53,6	142,7	47,6	95,1	33,4	9,413
280EDQ	0,75	8	FORCE FIT	53,6	55,7	51,6	4,0	92,8	0,343

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 6/74	A- 1	G1149367	1971	FORD	GOOD	NO	100	68	0.00	0.10	65	67	5.4	0.730	9.00
STANDARD	8/ 6/74	A- 2	XGM133	1968	FORD	GOOD	YES	100	75	0.00	0.10	78	73	10.4	1.070	4.36
STANDARD	8/ 6/74	A- 3	E813363	1970	PLYMOUTH	GOOD	NO	0	78	0.84	0.10	81	77	12.2	1.600	4.28
STANDARD	8/ 6/74	A- 4	UML569	1967	RAMBLER	GOOD	NO	100	72	0.00	0.10	83	0	13.5	1.440	4.31
STANDARD	8/ 6/74	A- 5	KXK184	1965	DODGE	GOOD	NO	25	76	0.00	0.10	83	81	21.9	2.710	4.35
STANDARD	8/ 6/74	A- 6	9148GV	1970	VOLKSWAGON	GOOD	NO	100	70	0.00	0.01	82	82	5.6	0.760	4.31
STANDARD	8/ 6/74	A- 7	153B0T	1970	FORD	GOOD	NO	100	89	0.00	0.00	82	80	12.0	1.440	4.29
STANDARD	8/ 6/74	A- 8	349FJU	1972	FORD	GOOD	NO	20	84	7.50	0.01	83	80	19.9	2.730	4.31
STANDARD	8/ 6/74	A- 9	68264K	1970	FORD	GOOD	NO	80	76	0.00	0.10	82	80	16.7	2.300	4.25
STANDARD	8/ 6/74	A-10	X33803	1969	FORD	POOR	NO	100	76	0.00	0.10	83	80	14.3	1.620	4.23
STANDARD	8/ 6/74	A-11	XQK086	1968	CHEVROLET	GOOD	NO	10	73	0.00	0.10	83	80	8.9	1.090	4.34
STANDARD	8/ 6/74	A-12	T10304	1966	IH	GOOD	NO	100	0	0.00	0.00	83	80	10.0	0.630	4.29
STANDARD	8/ 6/74	A-13	740FDF	1972	BUICK	GOOD	NO	100	83	0.00	0.00	83	82	10.4	2.300	4.08
STANDARD	8/ 6/74	A-14	787HKG	1973	FORD	GOOD	NO	100	91	0.14	0.00	83	83	6.7	0.250	4.10
STANDARD	8/ 6/74	A-15	48427T	1974	GMC	GOOD	NO	100	0	0.00	-0.10	83	83	14.2	0.830	4.24
STANDARD	8/ 6/74	A-16	062EEZ	1972	MERCURY	GOOD	NO	100	92	0.00	-0.05	83	84	11.0	1.130	4.26
STANDARD	8/ 6/74	A-17	613EEQ	1971	FORD	GOOD	NO	100	83	0.40	-0.05	83	84	12.3	1.270	4.27
STANDARD	8/ 6/74	A-18	XG8638	1970	PLYMOUTH	GOOD	NO	40	92	0.00	-0.10	85	86	11.9	0.830	4.22
STANDARD	8/ 6/74	A-19	WNB819	1968	VOLKSWAGON	GOOD	NO	45	87	0.00	0.10	85	86	8.9	1.110	4.27
STANDARD	8/ 6/74	A-20	504EFZ	1972	FORD	GOOD	NO	100	94	0.00	-0.10	85	87	7.2	0.000	4.19
STANDARD	8/ 6/74	A-21	66439N	1973	FORD	GOOD	NO	0	0	0.00	-0.10	85	87	17.0	1.420	4.31
STANDARD	8/ 6/74	A-22	179KVA	1974	CHEVROLET	GOOD	NO	0	98	0.09	-0.10	84	88	12.4	1.310	4.25
STANDARD	8/ 6/74	A-23	ONA591	1969	CHEVROLET	GOOD	NO	0	122	0.00	-0.20	84	90	12.0	0.400	4.31
STANDARD	8/ 6/74	A-24	882JAY	1973	FORD	GOOD	NO	100	80	0.00	-0.05	83	88	13.3	*-289.	5.82
STANDARD	8/ 6/74	A-25	86752N	1973	CHEVROLET	POOR	NO	100	105	0.00	-0.20	84	90	10.0	0.130	4.44
STANDARC	8/ 6/74	A-26	690ARL	1971	VOLKSWAGON	GOOD	NO	100	96	0.00	-0.15	85	93	9.0	0.920	4.29
STANDARD	8/ 6/74	A-27	966CHQ	1971	MG	GOOD	NO	100	97	0.00	-0.20	87	97	5.4	0.560	4.38
STANDARD	8/ 6/74	A-28	ILDEW	1973	FORD	GOOD	NO	100	98	0.00	-0.30	86	96	14.3	1.500	4.23
STANDARD	8/ 6/74	A-29	69435P	1973	GMC	GOOD	NO	0	112	0.15	-0.35	85	96	17.3	1.690	4.24
STANDARD	8/ 6/74	A-30	G1149367	1971	FORD	GOOD	NO	100	95	0.29	-0.40	87	97	8.3	0.870	4.22
STANDARD	8/ 6/74	A-31	270JBQ	1974	DODGE	GOOD	NO	0	111	0.00	-0.15	87	100	10.1	0.930	4.15
STANDARD	8/ 6/74	A-32	BKW869	1962	FORD	GOOD	NO	0	103	0.00	-0.15	88	101	12.3	0.610	4.34
STANDARD	8/ 6/74	A-33	WUZ340	1968	FORD	GOOD	NO	100	97	0.00	0.00	86	96	9.0	0.510	4.60
STANDARD	8/ 6/74	B- 1	04199U	1974	DODGE	GOOD	NO	100	82	0.00	-0.18	74	71	19.1	0.487	5.26
STANDARD	8/ 6/74	B- 2	226AOG	1970	VOLKSWAGON	GOOD	NO	0	78	0.00	-0.04	77	75	5.4	0.873	3.90
STANDARD	8/ 6/74	B- 3	ZW549	1969	TOYOTA	GOOD	NO	20	92	0.00	-0.08	82	77	7.5	0.856	5.62
STANDARD	8/ 6/74	B- 4	033FOF	1971	CHRYSLER	GOOD	NO	100	82	0.00	-0.14	82	77	16.6	1.800	5.44

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LICENSE    VAPOR  DELTA  VEHICLE              SAT    BASE     ACT     AMT    HC X     HC
           LIQUID TEMP   DESIGNATION           HC     RET     RET      HC    RECV  EMISS
           RATIO                             CONC      HC      HC    LOST    BASE  GM/GAL
61149367    1,01      3 REGULAR              34,8    18,5    20,9    -2,4   113,0 -0,445
XGM133      0,77     -3 FORCE FIT            38,5    43,9    33,8    10,1    77,0  0,972
E813363     0,98     -3 BASELINE             41,1    55,1    54,1     1,0    98,1  0,084
UML569      0,80    -11 REGULAR              11,4    19,3    13,5     5,8    70,0  0,430
KXK184      0,93     -7 REGULAR              43,9   113,1    97,8    15,2    86,5  0,695
914BGV      1,02    -12 REGULAR              44,7    31,8    27,9     3,9    87,7  0,696
153BDT      0,90      7 REGULAR              43,2    47,0    51,1    -4,1   108,8 -0,345
349FJU      1,03      1 FORCE FIT            43,2    87,8    96,9    -9,1   110,4 -0,457
08284K      1,03     -6 REGULAR              43,2    83,4    81,7     1,7    97,9  0,104
X33003      0,85     -7 REGULAR              43,2    72,6    57,5    15,1    79,2  1,055
XQK086      0,92    -10 REGULAR              43,2    47,4    38,7     8,7    81,7  0,977
T10304      0,47    -83 INST, FAIL.          43,2   113,8    22,4    91,4    19,7  9,145
748FDF      0,94      0 REGULAR              44,7    85,5    84,4     1,1    98,7  0,060
787HKG      0,28      8 FORCE FIT            45,4    27,0     9,3    17,7    34,6  2,637
48427T      0,46    -83 INST, FAIL.          45,4   169,9    32,8   137,0     9,3  9,651
062EEZ      0,77      9 REGULAR              46,2    44,1    42,9     1,2    97,3  0,109
013EEQ      0,77      0 FORCE FIT            46,2    59,1    48,2    10,9    81,5  0,800
XG8638      0,52      7 REGULAR              47,7    51,5    32,6    18,9    63,2  1,590
WN8819      0,93      2 REGULAR              47,7    42,6    43,5    -1,0   102,2 -0,107
504EFZ      0,00      9 REGULAR              48,5    30,3     0,0    30,3     0,0  4,213
06439N      0,60    -85 INST, FAIL.          48,5   228,3    56,6   171,7    24,8  9,754
179KVA      0,79     14 BASELINE             49,3    47,2    53,1    -5,9   112,5 -0,475
ONA591      0,28     38 BASELINE             51,0    20,3    20,1     0,2    99,0  0,016
082JAY   -163,01     -3 INST, FAIL.          49,3    72,1*-1175411826,3*-16305889,194
06752N      0,09     21 REGULAR              51,0    32,5     5,4    27,1    16,7  2,700
098ARL      0,76     11 REGULAR              53,6    40,0    40,5    -0,5   101,3 -0,057
966CHQ      0,78     10 REGULAR              57,3    26,3    26,4    -0,1   100,4 -0,010
ILDEW       0,78     12 FORCE FIT            56,3    65,3    69,5    -4,2   106,4 -0,291
09435P      0,73     27 BASELINE             56,3    50,9    78,3   -27,3   153,7 -1,501
G1149367    0,78      8 REGULAR              57,3    42,2    41,0     1,2    97,1  0,147
278J00      0,69     24 BASELINE             60,2    35,3    46,0   -10,7   130,5 -1,064
BKW869      0,37     15 BASELINE             61,2    56,7    30,7    26,0    54,1  2,115
HUZ340      0,42     11 REGULAR              56,3    42,1    23,6    18,5    56,1  2,051
04199U      0,19      8 REGULAR              37,2    63,1    14,9    48,2    23,6  2,522
226AOG      1,21      1 REGULAR              39,8    21,9    28,5    -6,6   130,1 -1,221
ZW549       0,85     10 REGULAR              41,1    26,2    28,9    -2,7   110,5 -0,367
033FDF      0,82      0 REGULAR              41,1    71,0    61,1     9,9    86,0  0,507
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 6/74	B- 5	Z927	1968		GOOD	NO	0	78	0,00	-0,14	82	77	8,3	1,000	5,30
STANDARD	8/ 6/74	B- 6	444DHX	1971	PONTIAC	GOOD	NO	100	100	0,62	-0,18	83	81	5,4	0,529	5,49
STANDARD	8/ 6/74	B- 7	VJN624	1967	OPEL	GOOD	NO	100	90	0,00	-0,20	87	81	5,4	0,269	5,23
STANDARD	8/ 6/74	B- 8	AVA614	1964	PLYMOUTH	GOOD	NO	100	72	0,00	-0,16	82	78	9,3	1,132	5,75
STANDARD	8/ 6/74	B- 9	VJC039	1965	JEEP	POOR	NO	100	92	0,00	-0,18	81	77	11,2	0,086	4,00
STANDARD	8/ 6/74	B-10	705GES	1973	MERC	GOOD	NO	100	78	0,00	0,10	77	77	5,8	0,652	5,56
STANDARD	8/ 6/74	B-11	719HCE	1973	CHEVROLET	GOOD	NO	100	88	2,00	-0,02	76	77	12,7	0,027	10,44
STANDARD	8/ 6/74	B-12	291FQD	1972	CHEVROLET	GOOD	NO	0	80	0,50	0,08	78	73	10,9	1,471	5,45
STANDARD	8/ 6/74	B-13	298FXP	1973	BUICK	GOOD	NO	100	101	0,09	0,00	76	74	7,0	0,010	6,00
STANDARD	8/ 6/74	B-14	773JTF	1973	CADILLAC	GOOD	NO	0	98	1,30	0,02	81	80	6,5	0,284	6,39
STANDARD	8/ 6/74	B-15	63899M	1973	DODGE	GOOD	NO	100	70	0,00	0,24	82	81	14,3	1,874	6,81
STANDARD	8/ 6/74	B-16	335398	1973	FORD	GOOD	NO	100	86	0,22	0,03	80	82	9,1	0,903	5,57
STANDARD	8/ 6/74	B-17	029JAY	1973	DODGE	GOOD	NO	0	80	0,63	0,13	82	82	11,6	1,685	5,12
STANDARD	8/ 6/74	B-18	VPD488	1964	FORD	GOOD	NO	100	82	0,00	0,09	82	83	15,5	1,385	6,64
STANDARD	8/ 6/74	B-19	722FQU	1972	DODGE	GOOD	NO	100	89	0,00	-0,20	85	107	18,1	1,092	8,35
STANDARD	8/ 6/74	B-20	WHT816	1968	CHEVROLET	GOOD	YES	100	96	0,00	0,09	85	85	7,2	0,242	5,27
STANDARD	8/ 6/74	B-21	W26300	1973	LINCOLN	GOOD	NO	0	111	0,00	0,15	86	85	20,1	1,101	5,29
STANDARD	8/ 6/74	B-22	935DXJ	1971	CHEVROLET	GOOD	NO	100	101	0,05	-0,06	85	86	7,7	0,742	5,13
STANDARD	8/ 6/74	B-23	728EDT	1972	FORD	GOOD	NO	0	96	0,25	0,01	87	86	7,3	0,693	5,41
STANDARD	8/ 6/74	B-24	025953	1973	PLYMOUTH	GOOD	NO	0	98	0,00	0,03	86	86	10,8	0,705	5,14
STANDARD	8/ 6/74	B-25	654AFC	1971	VOLKSWAGON	GOOD	NO	100	96	0,00	0,18	88	85	7,0	0,607	5,92
STANDARD	8/ 6/74	B-26	TEMP.	1974	DODGE	GOOD	NO	0	109	0,23	0,01	88	87	8,2	0,150	5,18
STANDARD	8/ 6/74	B-27	55174L	1972	FORD	GOOD	NO	0	107	0,00	0,08	85	85	9,0	0,624	7,30
STANDARD	8/ 6/74	B-28	9958GV	1970	CHRYSLER	GOOD	NO	10	96	3,00	0,26	88	87	10,0	1,290	5,41
STANDARD	8/ 6/74	B-29	422LFH	1974	PLYMOUTH	GOOD	NO	20	97	3,10	0,18	86	90	14,0	1,777	6,89
STANDARD	8/ 6/74	B-30	K01521	1961	INT	GOOD	NO	15	95	0,00	0,10	88	89	11,0	0,885	4,89
STANDARD	8/ 6/74	B-31	SNW426	1965	FORD	GOOD	NO	100	98	0,00	-0,15	85	90	11,3	0,583	5,60
STANDARD	8/ 6/74	B-32	693CHO	1971	DATSUN	GOOD	NO	100	101	0,00	-0,10	88	90	8,9	0,169	5,04
STANDARD	8/ 6/74	B-33	720GDC	1972	VOLVO	POOR	NO	100	99	0,00	-0,08	92	96	14,1	0,420	5,13
STANDARD	8/ 6/74	B-34	PC40862	1966	CHEVROLET	GOOD	NO	55	101	0,00	0,05	90	97	9,0	1,015	5,14
STANDARD	8/ 7/74	A- 1	845ECC	1972	FORD	GOOD	NO	100	84	0,81	-0,05	85	85	17,4	2,140	4,23
STANDARD	8/ 7/74	A- 2	0958GW	1970	FORD	GOOD	NO	0	79	0,10	0,10	86	85	7,4	0,950	2,66
STANDARD	8/ 7/74	A- 3	334EDG	1972	FORD	GOOD	NO	0	85	0,00	0,15	86	86	16,2	2,020	4,28
STANDARD	8/ 7/74	A- 4	033JVT	1969	VOLKSWAGON	GOOD	NO	100	94	0,00	0,15	85	85	9,1	1,130	4,27
STANDARD	8/ 7/74	A- 5	870BVU	1971	VOLKSWAGON	GOOD	NO	0	88	0,00	-0,20	86	88	10,3	1,360	4,29
STANDARD	8/ 7/74	A- 6	300778	1968	FORD	POOR	NO	100	79	0,00	0,10	85	88	13,0	1,620	4,26
STANDARD	8/ 7/74	A- 7	582BGC	1970	CHEVROLET	GOOD	NO	20	85	0,56	0,10	86	88	12,8	1,570	4,29

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LICENSE    VAPOR  DELTA  VEHICLE              SAT    BASE    ACT     AMT    HC X      HC
           LIQUID TEMP   DESIGNATION           HC     RET    RET      HC    RECV   EMISS
           RATIO                             CONC      HC     HC    LOST    BASE  GM/GAL
Z927        0,97    -4 FORCE FIT             41,1    38,1   36,5     1,6    95,7   0,198
444DHX      0,73    17 FORCE FIT             43,9    16,9   19,1    -2,2   112,7  -0,398
VJN624      0,37     3 REGULAR               43,9    23,3    9,7    13,6    41,6   2,521
AVA614      0,91   -10 REGULAR               41,8    47,9   38,9     9,0    81,1   0,972
7JC839      0,86    11 REGULAR               41,1    38,2    2,9    35,3     7,6   3,151
705GES      0,98     1 REGULAR               41,1    21,0   22,0    -1,0   104,9  -0,206
719HCE      0,82    10 FORCE FIT             41,1    44,3    0,9    43,4     2,1   3,417
391FQD      1,01     2 BASELINE              38,5    42,0   46,5    -4,5   110,6  -0,410
290FXP      0,81    25 FORCE FIT             39,1    15,4    0,3    15,0     2,1   2,147
773JTF      0,33    17 BASELINE              43,2    20,1   10,1    10,0    50,3   1,535
03899M      0,98   -12 REGULAR               43,9    79,9   67,7    12,2    84,7   0,853
335398      0,74     6 REGULAR               44,7    37,6   33,1     4,5    88,1   0,492
029JAY      1,03    -2 BASELINE              44,7    55,9   58,9    -3,0   105,4  -0,259
VPD408      0,67     8 REGULAR               45,4    73,3   51,7    21,6    70,6   1,392
722FQU      0,45     4 REGULAR               67,6   118,0   60,7    57,3    51,4   3,187
WHT810      0,25    11 REGULAR               46,9    20,0    9,3    10,7    33,3   2,598
N26300      0,41    25 REGULAR               46,9    52,9   42,5    10,4    80,3   0,520
935DXJ      0,72    16 FORCE FIT             47,7    27,0   29,1    -2,1   107,9  -0,278
728EDT      0,71     9 BASELINE              47,7    30,2   27,2     3,1    89,9   0,419
025953      0,49    12 REGULAR               47,7    41,8   27,7    14,1    66,2   1,308
654AFC      0,65     8 REGULAR               46,9    29,2   23,4     5,7    80,3   0,820
TEMP,       0,14    21 BASELINE              48,5    25,4    6,3    19,1    24,8   2,326
55174L      0,52    22 REGULAR               46,9    26,1   24,1     2,1    92,1   0,228
995BGV      0,96     8 FORCE FIT             48,5    43,1   51,5    -8,4   119,5  -0,839
422LFH      0,95    11 FORCE FIT             51,0    59,2   74,5   -15,2   125,7  -1,089
K91521      0,60     7 REGULAR               50,2    50,0   36,5    13,5    72,9   1,238
8NW426      0,39    13 REGULAR               51,0    45,6   24,4    21,2    53,6   1,873
093CHO      0,14    13 REGULAR               51,0    35,9    7,1    28,8    19,7   3,240
720GDC      0,22     7 REGULAR               56,3    72,0   19,5    52,6    27,0   3,728
PC40862     0,84    11 REGULAR               57,3    42,8   47,8    -5,0   111,7  -0,557
845ECC      0,92    -1 FORCE FIT             46,9    86,6   82,6     4,0    95,4   0,231
095BGW      0,96    -7 BASELINE              46,9    40,8   36,7     4,2    89,9   0,564
334EDG      0,93    -1 REGULAR               47,7    82,0   79,2     2,7    96,7   0,168
033JVT      0,93     9 REGULAR               46,9    37,1   43,6    -6,5   117,6  -0,715
8700VU      0,99     2 REGULAR               49,3    50,9   55,2    -4,2   108,3  -0,409
308770      0,93    -5 REGULAR               49,3    74,2   65,7     8,5    88,6   0,651
5828GC      0,92    -1 FORCE FIT             49,3    67,0   63,7     3,3    95,1   0,256
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 STATION    DATE    TEST LICENSE  YEAR   MAKE        TYPE SPT EXP VEH   VEH    SYS GAS VAP AMT     VOL        DISP
                     NO                               OF  BAK RDG  TK    TK    PRES TMP TMP GAS    VAP        RATE
                                                      FIT             TMP  PRES                   DISP
STANDARD  8/ 7/74 A- 8 DL610    1974 BUICK       GOOD NO    0    0 -0,20 -0,20 88 90 11.5     0.490       4,26
STANDARD  8/ 7/74 A- 9 TOR073   1963 VOLKSWAGON  POOR NO  100   85  0,00 -0,20 89 93  7.7     0.000       2,87
STANDARD  8/ 7/74 A-10 YLZ244   1969 RAMBLER     POOR NO  100  104  0,00 -0,02 88 95  5.3     0.060       4,24
STANDARD  8/ 7/74 A-11 998FQ0   1973 FORD        GOOD NO   10  104  0,00 -0,20 88 95 19.8     2.060       4,24
STANDARD  8/ 7/74 A-12 844JWE   1972 FORD        GOOD NO  100   99  0,35 -0,20 88 97 11.8     1.240       3,96
STANDARD  8/ 7/74 A-13 551EMI   1972 FORD        GOOD NO   10  109  0,00 -0,20 88 95  9.1     0.680       2,92
STANDARD  8/ 7/74 A-14 402JAY   1973 FORD        GOOD NO  100  106  0,00 -0,20 88 95 15.8     1.070       4,23
STANDARD  8/ 7/74 A-15 594511   1972 AM MOTORS   GOOD NO  100   96  0,00 -0,50 87 93 11.2     0.800       9,46
STANDARD  8/ 7/74 A-16 575BVA   1970 OLDSMOBILE  POOR NO  100   84  0,00 -0,20 88 97 13.2     0.010       6,24
STANDARD  8/ 7/74 A-17 64289P   1974 FORD        GOOD NO  100   96  0,79 -0,20 87 95 10.8     1.070       8,76
STANDARD  8/ 7/74 A-18 AVE109   1966 FORD        GOOD NO   55  109  0,00 -0,20 87 95 19.4     0.760       4,31
STANDARD  8/ 7/74 A-19 999KTP   1974 FORD        GOOD NO   20  101  0,75 -0,10 87 97  6.8     0.540       8,87
STANDARD  8/ 7/74 A-20 BOTJON   1973 TOYOTA      GOOD NO  100   95  0,00  0,10 87 93  8.8     0.870       4,22
STANDARD  8/ 7/74 A-21 820DHT   1971 CHEVROLET   GOOD NO    0  102  0,65 -0,30 86 90 10.5     1.070       9,34
STANDARD  8/ 7/74 A-22 BQV394   1958 FORD        POOR NO   60   86  0,00  0,05 85 90 14.5     1.750       8,79
STANDARD  8/ 7/74 A-23 699JBB   1973 FORD        GOOD NO   55   88  0,00 -0,05 87 88  5.4     0.550       4,21
STANDARD  8/ 7/74 A-24 XUT466   1969 VOLKSWAGON  GOOD NO  100   84  0,00 -0,20 87 88  7.5     0.810       2,71
STANDARD  8/ 7/74 A-25 202KUS   1967 OLDSMOBILE  POOR NO  100   94  0,00 -0,20 85 86  4.3     0.430       4,45
STANDARD  8/ 7/74 A-26 UMS865   1967 CHEVROLET   GOOD NO  100   92  0,00 -0,05 87 88 12.5     0.010       9,26
STANDARD  8/ 7/74 A-27 369868   1971 TOYOTA      GOOD NO  100   89  0,00  0,20 87 88 11.6     1.430       9,28
STANDARD  8/ 7/74 A-28 NAS581   1964 FORD        POOR NO  100   90  0,00 -0,20 85 87  5.4     0.440       3,95
STANDARD  8/ 7/74 A-29 HDW837   1955 FORD        POOR NO  100   86  0,00  0,20 85 87  5.4     0.000       8,76
STANDARD  8/ 7/74 A-30 WND569   1968 FORD        GOOD NO  100   86  0,00 -0,20 85 85  5.4     0.560       4,32
STANDARD  8/ 7/74 A-31 254JWC   1972 TOYOTA      GOOD NO   20   82  0,00  0,10 84 85  5.4     0.510       4,91
STANDARD  8/ 7/74 B- 1 145EEZ   1972 CHEVROLET   GOOD NO    0   90  0,39 -0,08 77 77  6.2     0.656       6,41
STANDARD  8/ 7/74 B- 2 CVC614   1971 MERC        GOOD NO    0  115  0,00 -0,20 81 82 16.3     0.916       6,99
STANDARD  8/ 7/74 B- 3 RLG037   1966 LINCOLN     GOOD NO    0   86  0,00 -0,12 82 82 12.0     1.679       5,76
STANDARD  8/ 7/74 B- 4 R414     1966 VOLKSWAGON  POOR NO  100   81  0,00  0,24 82 82  6.0     0.252       5,22
STANDARD  8/ 7/74 B- 5 687GDS   1973 FORD        GOOD NO    0  113  0,00 -0,22 83 83 13.4     0.542      10,18
STANDARD  8/ 7/74 B- 6 35083B   1967 FORD        GOOD NO  100   86  0,00 -0,16 85 85 13.2     1.774       5,58
STANDARD  8/ 7/74 B- 7 YUB234   1969 AUSTIN AME  GOOD NO   20   83  0,00 -0,16 87 87  5.6     0.333       4,28
STANDARD  8/ 7/74 B- 8 CY24     1974 PORSCHE     POOR NO  100   94  0,00 -0,24 84 86 14.0     0.119       5,32
STANDARD  8/ 7/74 B- 9 20598W   1974 CHEVROLET   POOR YES 100    0  0,34 -0,22 85 90 14.3     0.419       3,57
STANDARD  8/ 7/74 B-10 765AXC   1970 FORD        POOR YES 100   90  0,06 -0,22 85 86 16.1     0.718       9,56
STANDARD  8/ 7/74 B-11 409FQD   1973 FORD        GOOD NO    0   98  0,12 -0,18 85 87  9.5     0.762       4,75
STANDARD  8/ 7/74 B-12 826JAW   1973 DODGE       GOOD NO  100  100  5,00 -0,14 80 86  4.5     0.392       5,09
STANDARD  8/ 7/74 B-13 617MKS   1973 MERCURY     GOOD NO   35   98  0,20 -0,06 84 81  5.4     0.533       8,53
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LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
0L610	0,32	-80	INST, FAIL,	51,0	151,2	20,5	130,6	13,6	11,358
TOR073	0,00	-4	REGULAR	53,6	46,1	0,0	46,1	0,0	5,992
YLZ244	0,08	16	REGULAR	55,4	21,6	2,7	18,8	12,7	3,550
998FQG	0,78	16	REGULAR	55,4	80,5	93,8	-13,3	116,6	-0,673
844JHE	0,79	11	FORCE FIT	57,3	56,1	58,4	-2,3	104,1	-0,198
551EMI	0,56	21	REGULAR	55,4	32,2	31,0	1,2	96,3	0,129
482JAY	0,51	18	REGULAR	55,4	60,9	48,7	12,2	80,0	0,769
594511	0,53	9	REGULAR	53,6	52,1	35,3	16,9	67,6	1,506
575BVA	0,01	-4	REGULAR	57,3	84,5	0,5	84,1	0,6	6,368
04289P	0,74	9	FORCE FIT	55,4	52,0	48,7	3,2	93,8	0,298
AVE109	0,29	22	REGULAR	55,4	66,5	34,6	31,9	52,1	1,643
990KTP	0,59	14	FORCE FIT	57,3	30,1	25,4	4,6	84,5	0,684
0DTJON	0,74	8	REGULAR	53,6	41,9	38,3	3,5	91,6	0,400
020DHT	0,48	16	BASELINE	51,0	61,7	44,8	16,9	72,6	1,024
00V394	0,90	1	REGULAR	51,0	75,6	73,4	2,2	97,1	0,152
099J00	0,76	1	REGULAR	49,3	27,2	22,3	4,9	81,9	0,910
XUT466	0,81	-3	REGULAR	49,3	40,7	32,9	7,8	80,8	1,040
202KUS	0,75	9	REGULAR	47,7	17,8	16,9	1,0	94,7	0,221
UM3865	0,48	5	REGULAR	49,3	58,3	32,9	25,4	56,4	2,034
369865	0,92	2	REGULAR	49,3	57,4	58,0	-0,6	101,1	-0,053
NAS581	0,61	5	REGULAR	48,5	24,8	17,5	7,2	70,9	1,336
HDW037	0,00	1	REGULAR	48,5	26,8	0,0	26,8	0,0	4,958
WND569	0,78	1	REGULAR	46,9	25,9	21,6	4,3	83,4	0,795
254JWC	0,71	-2	REGULAR	46,9	27,4	19,7	7,7	71,9	1,423
145EEZ	0,79	13	BASELINE	41,1	20,2	22,2	-2,0	109,9	-0,322
CVC614	0,42	34	REGULAR	44,7	28,3	33,5	-5,4	119,0	-0,330
RLG037	1,05	4	FORCE FIT	44,7	51,7	61,6	-10,0	119,3	-0,830
R414	0,31	-1	REGULAR	44,7	28,4	9,3	19,2	32,6	3,193
087GD8	0,30	30	REGULAR	45,4	28,3	20,2	8,1	71,5	0,601
360038	1,01	1	REGULAR	46,9	63,3	68,4	-5,1	108,1	-0,389
YU0234	0,44	-4	REGULAR	48,5	30,4	13,3	17,1	43,7	3,052
CY24	0,06	10	REGULAR	47,7	56,7	4,7	52,1	8,2	3,718
20598H	0,22	-65	BAD READING	51,0	195,0	17,6	177,4	9,0	12,406
765AXC	0,33	5	REGULAR	47,7	72,6	28,2	44,4	38,8	2,760
409FOD	0,60	13	BASELINE	48,5	36,5	30,4	6,1	83,3	0,641
026JAH	0,65	14	FORCE FIT	47,7	16,6	15,4	1,2	92,7	0,268
017HKS	0,74	14	FORCE FIT	43,9	18,3	19,2	-0,9	105,1	-0,172

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 7/74	B-16	JIMC04	1973	FORD	GOOD	NO	0	107	-0,20	-0,16	84	86	17,2	1,117	5,32
STANDARD	8/ 7/74	B-17	VJW011	1962	CHEVROLET	GOOD	NO	100	101	0,00	-0,20	84	85	14,1	0,935	9,00
STANDARD	8/ 7/74	B-18	719MCE	1973	CHEVROLET	POOR	NO	100	105	0,00	-0,10	86	82	18,3	0,833	5,49
STANDARD	8/ 7/74	B-19	905FMT	1973	CHEVROLET	GOOD	NO	100	102	0,39	-0,10	85	85	4,6	0,406	5,87
STANDARD	8/ 7/74	B-20	3178G4	1970	PONTIAC	GOOD	NO	0	111	0,00	-0,20	85	86	10,7	0,950	5,14
STANDARD	8/ 7/74	B-22	663928	1963	FORD	GOOD	NO	20	103	0,00	-0,08	84	82	8,5	0,803	5,67
STANDARD	8/ 7/74	B-22	844JAM	1973	MERCURY	GOOD	NO	0	103	0,00	-0,01	82	87	10,4	0,989	5,07
STANDARD	8/ 7/74	B-23	ASH864	1964	RAMBLER	POOR	YES	100	96	0,00	-0,18	81	83	5,6	0,203	4,15
STANDARD	8/ 7/74	B-24	165GDO	1972	CADALLAC	GOOD	NO	100	89	0,19	-0,10	80	83	24,0	2,075	5,83
STANDARD	8/ 7/74	B-25	122AXU	1970	VOLKSWAGON	GOOD	NO	100	84	0,00	-0,05	78	83	9,2	0,954	10,22
STANDARD	8/ 7/74	B-26	MZX709	1963	RAMBLER	POOR	NO	100	90	0,00	-0,14	77	80	9,1	0,597	7,58
STANDARD	8/ 7/74	B-27	MZZ837	1963	VOLKSWAGON	POOR	NO	100	90	0,00	-0,04	75	77	9,3	0,400	7,86
STANDARD	8/ 7/74	B-18	771JVG	1972	CHEVROLET	GOOD	NO	0	83	5,00	0,38	75	77	15,2	2,274	10,25
STANDARD	8/ 7/74	B-29	SNE864	1966		GOOD	NO	0	84	0,00	-0,22	76	78	14,1	0,187	5,72
STANDARD	8/ 7/74	B-30	657BGD	1969	CHEVROLET	GOOD	NO	60	94	0,00	-0,19	75	77	5,4	0,559	5,31
STANDARD	8/ 7/74	B-31	63951M	1973	DODGE	GOOD	NO	0	80	0,00	-0,04	75	78	18,6	4,376	7,29
STANDARD	8/ 8/74	A- 1	248FD6	1972	CHEVROLET	GOOD	NO	0	80	0,00	-0,20	82	74	10,0	2,000	5,79
STANDARD	8/ 8/74	A- 2	3636CN	1974	CHEVROLET	GOOD	NO	0	80	0,75	-0,20	86	80	14,3	2,070	4,45
STANDARD	8/ 8/74	A- 3	640CGX	1971		GOOD	NO	0	84	0,00	-0,20	87	82	13,2	1,830	4,26
STANDARD	8/ 8/74	A- 4	VQY404	1968	PLYMOUTH	GOOD	NO	100	83	0,00	-0,20	85	83	5,4	0,510	4,21
STANDARD	8/ 8/74	A- 5	719GQA	1973	FORD	GOOD	NO	100	97	0,00	-0,20	85	80	9,6	0,440	9,14
STANDARD	8/ 8/74	A- 6	559404	1974	AMERICAN	GOOD	NO	100	85	1,50	-0,20	85	80	15,3	1,810	9,27
STANDARD	8/ 8/74	A- 7	617HKS	1973	MERCURY	GOOD	NO	0	80	0,00	-0,20	85	80	17,4	2,240	5,80
STANDARD	8/ 8/74	A- 8	63988K	1970	FORD	GOOD	NO	55	82	2,00	6,01	84	80	13,8	1,760	9,52
STANDARD	8/ 8/74	A- 9	753GQ2	1971	CHEVROLET	POOR	NO	100	113	0,00	-0,20	84	78	6,5	0,300	4,29
STANDARD	8/ 8/74	A-10	690JAN	1973	CHEVROLET	GOOD	NO	100	78	1,30	-0,20	84	78	8,4	0,940	9,16
STANDARD	8/ 8/74	A-11	X2P598	1968	HONDA	POOR	NO	60	89	0,00	0,00	0	0	0,0	*-342,	-1,00
STANDARD	8/ 8/74	A-12	293FDW	1972	DATSUN	GOOD	NO	100	82	0,00	-0,20	85	0	3,3	0,340	4,30
STANDARD	8/ 8/74	A-13	SWG250	1966	VOLKSWAGON	POOR	NO	100	80	0,00	-0,20	85	80	7,4	0,070	4,19
STANDARD	8/ 8/74	A-14	P60661	1964	FORD	GOOD	NO	100	77	0,00	-0,20	85	80	14,1	1,000	8,91
STANDARD	8/ 8/74	A-15	5918WZ	1967	FORD	GOOD	NO	100	85	0,00	-0,20	85	80	4,3	0,000	3,97
STANDARD	8/ 8/74	A-16	XKN818	1969	VOLKSWAGON	GOOD	NO	20	85	0,00	-0,20	85	83	8,2	1,110	4,43
STANDARD	8/ 8/74	A-17	513FDF	1972	FORD	GOOD	NO	100	81	0,00	-0,20	85	83	6,6	0,630	4,30
STANDARD	8/ 8/74	A-18	P28843	1964	CHEVROLET	GOOD	NO	100	88	0,00	-0,20	85	83	12,0	1,000	4,24
STANDARD	8/ 8/74	A-19	791FQR	1972	DATSUN	POOR	NO	100	94	0,00	-0,30	85	83	5,4	0,000	4,26
STANDARD	8/ 8/74	A-20	989KWG	1974	AUDI	GOOD	NO	40	88	0,00	-0,30	85	83	10,0	1,000	5,56
STANDARD	8/ 8/74	A-21	441KIU	1974	HONDA	GOOD	NO	100	91	0,00	-0,30	85	84	6,3	0,740	4,25

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LICENSE   VAPOR  DELTA  VEHICLE          SAT    BASE     ACT      AMT    HC %      HC
          LIQUID TEMP   DESIGNATION       HC     RET     RET       HC    RECV    EMISS
          RATIO                         CONC      HC      HC     LOST    BASE   GM/GAL
 JIMC04    0.49    23 BASELINE          47.7    49.2    43.8      5.4    89.1    0.313
 VJN011    0.50    17 REGULAR           46.9    47.3    36.1     11.2    76.3    0.796
 719HCE    0.01    19 REGULAR           44.7    55.3     1.2     54.0     2.2    2.953
 905PMT    0.66    17 FORCE FIT         46.9    15.4    15.7     -0.2   101.5   -0.051
 317BG4    0.67    25 BASELINE          47.7    27.7    37.7    -10.0   136.1   -0.934
 663920    0.71    19 REGULAR           44.7    25.7    29.5     -3.8   114.8   -0.448
 044JAM    0.71    21 REGULAR           46.5    32.2    39.4     -7.3   122.6   -0.698
 ASH864    0.27    15 REGULAR           45.4    19.1     7.6     11.6    39.6    2.066
 165GDO    0.65     9 FORCE FIT         45.4    94.6    77.4     17.2    81.9    0.715
 122AXU    0.78     6 REGULAR           45.4    38.7    35.6      3.1    92.1    0.333
 MZX709    0.49    13 REGULAR           43.2    31.1    21.2      9.9    68.1    1.889
 MZZ837    0.33    15 REGULAR           41.1    28.8    13.8     15.0    47.9    1.613
 771JVG    1.12     8 BASELINE          41.1    55.4    76.8    -21.4   138.6   -1.407
 SNE064    0.09     8 REGULAR           41.8    52.3     6.4     45.9    12.3    3.253
 057B6D    0.77    19 REGULAR           41.1    15.0    18.9     -3.9   125.8   -0.718
 03951M    1.76     5 REGULAR           41.8    73.4   150.3    -76.9   204.6   -4.132
 248FDG    0.89    -2 REGULAR           39.1    70.9    64.3      6.6    90.7    0.394
 3636CN    1.08    -6 BASELINE          43.2    71.4    73.5     -2.1   102.9   -0.145
 640CGX    1.04    -3 REGULAR           44.7    64.8    67.2     -2.4   103.7   -0.168
 V0Y404    0.71    -2 REGULAR           45.4    26.5    19.0      7.4    71.9    1.376
 719GQA    0.34    12 REGULAR           43.2    33.6    15.6     18.0    46.5    1.874
 559404    0.88     0 FORCE FIT         43.2    68.8    64.3      4.5    93.4    0.296
 617HK8    0.96    -5 REGULAR           43.2    85.5    79.5      5.9    93.1    0.341
 63986K    0.95    -2 FORCE FIT         43.2    64.3    62.5      1.9    97.1    0.134
 753B02    0.35    29 REGULAR           41.8    13.1    10.3      2.8    78.4    0.437
 090JAN    0.84    -6 FORCE FIT         41.8    40.6    32.3      8.3    79.6    0.988
 X2P598    0.00    89 BAD READING       11.4     0.0-3224.7   3224.7    -1.0   -1.000
 293FDW    0.77    -3 FORCE FIT         11.4     4.1     3.2      0.9    77.1    0.286
 SWG250    0.07    -5 REGULAR           43.2    36.3     2.5     33.9     6.8    4.576
 P60661    0.99    -8 FORCE FIT         43.2    72.8    66.0      6.7    90.8    0.477
 591BWZ    0.00     0 REGULAR           43.2    19.3     0.0     19.3     0.0    4.497
 XKN816    1.01     8 FORCE FIT         45.4    38.8    41.4     -2.7   106.9   -0.326
 513FDF    0.71    -4 REGULAR           45.4    33.5    23.5     10.0    70.2    1.514
 P20043    0.62     3 FORCE FIT         45.4    53.6    37.3     16.3    69.7    1.355
 791FQR    0.00     9 REGULAR           45.4    21.3     0.0     21.3     0.0    3.942
 989KWG    0.75     3 FORCE FIT         45.4    44.7    37.3      7.3    83.6    0.733
 441KIU    0.88     6 REGULAR           46.2    26.9    28.1     -1.2   104.3   -0.183
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 8/74	A-22	864DEL	1971		GOOD	NO	60	97	0,00	-0,30	88	90	6,5	0,840	4,29
STANDARD	8/ 8/74	A-23	670JAE	1973	CHEVROLET	GOOD	NO	100	92	0,00	-0,40	90	93	13,8	1,260	4,25
STANDARD	8/ 8/74	A-24	430AAJ"'	1970	EVROLET	GOOD	NO	100	97	0,10	-0,10	88	92	8,0	0,560	6,29
STANDARD	8/ 8/74	A-25	0603300	1974	DATSUN	GOOD	NO	100	90	0,00	-0,05	90	92	7,3	0,740	4,38
STANDARD	8/ 8/74	A-26	927ATC	1961	MERCURY	GOOD	NO	100	91	0,00	-0,10	88	88	7,3	0,680	3,32
STANDARD	8/ 8/74	A-27	EMB888	1964	PLYMOUTH	GOOD	NO	100	91	0,00	-0,10	88	88	12,0	1,270	4,44
STANDARD	8/ 8/74	A-28	871060	1955	FORD	GOOD	NO	100	93	0,00	-0,20	88	88	10,5	1,160	9,13
STANDARD	8/ 8/74	A-29	381JAY	1973	CHEVROLET	GOOD	NO	20	93	-0,02	-0,07	92	94	17,7	0,010	4,41
STANDARD	8/ 8/74	A-30	714KUS	1948	PLYMOUTH	GOOD	NO	60	98	0,00	-0,03	90	97	5,4	0,730	7,53
STANDARD	8/ 8/74	A-31	AMX293	1963	RAMBLER	POOR	NO	100	94	0,00	-0,07	95	95	9,1	0,020	4,23
STANDARD	8/ 8/74	A-32	1830XJ	1971	TOYOTA	GOOD	NO	25	95	0,00	-0,12	90	0	6,4	0,460	4,92
STANDARD	8/ 8/74	A-33	31759F	1970	FORD	GOOD	NO	100	91	0,00	-0,09	93	94	13,1	1,460	4,23
STANDARD	8/ 8/74	A-34	710DAJ	1971	CHEVROLET	GOOD	NO	100	98	0,42	-0,08	91	92	13,1	1,500	4,52
STANDARD	8/ 8/74	A-35	133JBK	1973	DATSUN	GOOD	NO	100	102	0,00	-0,10	91	92	8,8	0,020	9,26

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LICENSE   VAPOR  DELTA  VEHICLE              SAT    BASE    ACT    AMT    HC %     HC
          LIQUID TEMP   DESIGNATION           HC     RET    RET     HC    RECV   EMISS
           RATIO                             CONC     HC     HC   LOST    BASE  GM/GAL
864DEL     0.97      9 REGULAR               51.0   28.8   35.2   -6.4   122.4  -0.998
670JAE     0.68      2 REGULAR               53.6   74.2   55.5   18.6    74.9   1.351
430AAJ"!   0.48      9 FORCE FIT             52.7   40.3   24.3   16.0    60.3   1.819
6603300    0.76      0 REGULAR               52.7   40.1   32.1    8.0    80.0   1.095
827ATC     0.70      3 FORCE FIT             49.3   35.4   27.6    7.8    77.9   1.074
EM0888     0.74      3 REGULAR               49.3   52.1   51.5   10.6    82.9   0.828
871360     0.83      5 FORCE FIT             49.3   49.0   47.0    1.9    96.1   0.181
301JAY     0.00      1 REGULAR               54.5   98.6    0.4   98.1     0.5   5.544
714KUS     1.01      8 REGULAR               57.3   27.5   34.4   -6.9   125.2  -1.282
AMX293     0.02     -1 REGULAR               55.4   53.5    0.9   52.6     1.7   5.775
1030XJ     0.54      5 REGULAR               11.4    6.9    4.3    2.6    62.5   0.405
31759F     0.83     -2 REGULAR               54.5   77.1   65.4   11.7    84.9   0.890
710DAJ     0.90      7 FORCE FIT             52.7   62.6   68.5   -5.9   109.4  -0.447
133JBK     0.70     11 REGULAR               52.7   38.5   35.5    3.0    92.3   0.337
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/ 9/74	A- 1	HEYDUK	1972	BUICK	GOOD	NO	0	83	2.70	0.25	85	67	19.4	2.840	9.62
STANDARD	8/ 9/74	A- 2	448FFK	1972	JEEP	GOOD	NO	0	0	0.00	0.20	82	74	14.0	1.830	5.56
STANDARD	8/ 9/74	A- 3	566JAT	1973	PLYMOUTH	GOOD	NO	0	86	1.30	0.10	81	75	8.8	0.950	5.56
STANDARD	8/ 9/74	A- 4	J97627	1961	FORD	POOR	NO	0	0	0.00	0.00	0	0	0.0	0.000	-1.00
STANDARD	8/ 9/74	A- 5	SMG698	1973	VOLKSWAGON	GOOD	NO	100	80	0.00	0.15	82	75	5.4	1.680	7.36
STANDARD	8/ 9/74	A- 6	654BOI	1970	OLDSMOBILE	GOOD	NO	0	0	0.00	-0.25	85	80	9.1	0.210	5.63
STANDARD	8/ 9/74	A- 7	167JWZ	1974	JEEP	GOOD	NO	0	0	0.00	0.00	85	80	15.4	1.790	5.57
STANDARD	8/ 9/74	A- 8	017FGW	1972	PONTIAC	GOOD	NO	0	105	0.00	0.05	84	80	13.6	0.990	5.55
STANDARD	8/ 9/74	A- 9	STARR1	1972	FORD	GOOD	NO	100	83	5.00	0.15	83	80	16.1	2.030	7.21
STANDARD	8/ 9/74	A-10	ZGX293	1967	CHEVROLET	GOOD	NO	100	83	0.00	-0.05	84	79	14.5	0.680	5.65
STANDARD	8/ 9/74	A-11	NAS581	1964	FORD	GOOD	NO	0	86	0.00	-0.05	84	80	6.4	0.600	7.68
STANDARD	8/ 9/74	B- 1	230EFJ	1971	FORD	GOOD	NO	100	72	0.00	-0.20	82	81	15.3	2.021	6.65
STANDARD	8/ 9/74	B- 2	250DAI	1965	CHEVROLET	GOOD	NO	100	83	0.00	0.08	82	87	11.7	1.311	5.40
STANDARD	8/ 9/74	B- 3	670EDY	1972	CHEVROLET	GOOD	NO	20	88	0.51	-0.11	82	87	10.0	1.338	5.17
STANDARD	8/ 9/74	B- 4	X950	1962	FORD	GOOD	NO	0	83	0.00	-0.04	78	85	6.0	-0.099	3.27
STANDARD	8/ 9/74	B- 5	MZT168	1963	CHEVROLET	GOOD	NO	0	89	0.00	0.12	79	87	12.4	1.119	5.24
STANDARD	8/ 9/74	B- 6	NSA418	1965	CHEVROLET	GOOD	NO	100	87	0.00	-0.04	81	89	6.4	0.444	6.00
STANDARD	8/ 9/74	B- 7	EYD626	1953	MERCURY	GOOD	NO	100	86	0.00	0.12	83	89	12.0	1.376	5.37
STANDARD	8/ 9/74	B- 8	256CCG	1974	FORD	GOOD	NO	100	84	0.81	0.08	84	85	8.3	0.886	7.90
STANDARD	8/ 9/74	B- 9	598BGA	1970	FORD	GOOD	NO	100	107	0.00	-0.09	84	77	17.1	1.163	5.37
STANDARD	8/ 9/74	B-10	106HBZ	1973	VOLKSWAGON	GOOD	NO	100	86	0.00	-0.07	84	83	7.4	0.601	5.16
STANDARD	8/ 9/74	B-11	911CKR	1971	CHEVROLET	GOOD	NO	100	89	0.00	0.05	84	83	19.3	2.253	5.46
STANDARD	8/ 9/74	B-12	350038	1969	FORD	GOOD	NO	0	88	0.00	0.15	84	85	10.5	1.122	6.00
STANDARD	8/ 9/74	B-13	690ARL	1971	VOLKSWAGON	GOOD	NO	100	82	0.00	-0.15	84	85	4.6	0.615	2.97
STANDARD	8/ 9/74	B-14	96T937	1972	FORD	GOOD	NO	0	101	0.25	0.04	84	90	8.9	0.686	5.50
STANDARD	8/12/74	A- 1	268HKK	1973	OLDSMOBILE	GOOD	NO	100	86	0.00	-0.40	75	75	12.4	0.970	5.55
STANDARD	8/12/74	A- 2	AMY705	1962	CHEVROLET	GOOD	NO	100	84	0.00	-0.05	75	75	13.1	1.460	5.91
STANDARD	8/12/74	A- 3	ZWW525	1969	VOLKSWAGON	POOR	NO	100	80	0.00	-0.20	75	74	13.9	0.820	5.56
STANDARD	8/12/74	A- 4	46577T	1974	FORD	POOR	YES	100	80	0.70	-0.05	75	74	15.3	1.720	5.63
STANDARD	8/12/74	A- 5	528DMB	1971	FORD	GOOD	NO	0	94	0.00	0.05	75	75	9.2	0.910	6.13
STANDARD	8/12/74	A- 6	550FDW	1972	BUICK	GOOD	NO	100	80	1.20	-0.10	75	75	18.3	1.970	9.07
STANDARD	8/12/74	A- 7	AUE429	1962	FORD	GOOD	NO	20	82	0.00	-0.05	75	76	10.7	1.240	6.42
STANDARD	8/12/74	A- 8	033FDF	1972	CHRYSLER	GOOD	NO	0	82	0.90	-0.05	75	76	21.0	2.790	7.97
STANDARD	8/12/74	A- 9	930GTY	1972	OLDSMOBILE	GOOD	NO	0	88	0.00	-0.05	75	77	7.5	0.750	6.08
STANDARD	8/12/74	A-10	965JVC	1972	TOYOTA	GOOD	NO	0	74	0.00	0.05	75	75	5.9	0.810	5.36
STANDARD	8/12/74	A-11	873COG	1971	VOLKSWAGON	GOOD	NO	100	78	0.00	-0.10	75	76	8.7	1.130	6.00
STANDARD	8/12/74	A-12	617HKS	1973	MERCURY	GOOD	NO	0	88	1.70	0.10	75	78	5.4	0.880	5.59

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LICENSE     VAPOR  DELTA  VEHICLE             SAT    BASE     ACT     AMT    HC %      HC
           LIQUID  TEMP   DESIGNATION          HC     RET     RET      HC    RECV   EMISS
            RATIO                            CONC      HC      HC    LOST    BASE  GM/GAL
HEYDUK       1.09    -2 BASELINE             34,8    74,5    81,3    -6,7   109.0  -0,347
448EFK       0,98   -82 INST. FAIL.          39,1   135,1    58.8    76,2    43,6   5,445
566JAI       0,81     5 BASELINE             39,8    34.4    31.0     3,4    90,2   0,385
J97627       0.00     0 INST. FAIL.          11,4     0.0     0.0     0,0    -1,0  -1,000
SMG698       2,33    -2 FORCE FIT            39,8    23,7    54,9   -31,2   231,8  -5,781
654BOI       0,17   -85 INST. FAIL.          43,2    99.0     7,5    91,5     7.5  10,059
167JWZ       0,87   -85 BAD READING          43,2   167,5    63,6   104,0    37,9   6,751
017FGW       0,54    21 REGULAR              43,2    41,8    35,2     6,6    84,1   0,488
STARR1       0,94     0 FORCE FIT            43,2    74,4    72,1     2,3    96,9   0,142
ZGX293       0,35    -1 REGULAR              42,5    66,9    23,8    43,2    35,5   2,978
NAS581       0,70     2 BASELINE             43,2    28,6    21,3     7,3    74,4   1,144
230EFJ       0,99   -10 REGULAR              43,9    83,3    73,0    10,4    87,6   0,677
250DAI       0,84     1 FORCE FIT            48,5    59,7    52,3     7,5    87,5   0,637
670EDY       1,00     6 FORCE FIT            48,5    46,9    53,4    -6,4   113,7  -0,644
X950        -0,12     5 BAD READING          46,9    27,7    -3,8    31,5   -13,8   5,258
MZT168       0,68    10 FORCE FIT            48,5    54,1    44,6     9,5    82,5   0,763
NSA418       0,52     6 REGULAR              50,2    31,0    18,3    12,7    59,0   1,991
EYD626       0,86     3 FORCE FIT            50,2    61,3    56,7     4,6    92,6   0,380
256CCG       0,73     0 FORCE FIT            46,9    41,7    31,1    10,6    74,6   1,273
598BGA       0,51    23 REGULAR              41,1    47,6    39,3     8,3    82,5   0,486
106HBZ       0,61     2 FORCE FIT            45,4    34,8    22,4    12,4    64,5   1,670
911CKR       0,87     5 REGULAR              45,4    86,2    84,1     2,2    97,5   0,112
350038       0,80     4 BASELINE             46,9    49,3    43,3     6,1    87,7   0,577
690ARL       1,00    -2 FORCE FIT            46,9    23,8    23,7     0,1    99,6   0,021
96T937       0,51    17 BASELINE             51.0    35,4    25.4    10,0    71,8   1,122
268HKK       0,59    11 REGULAR              39,8    43,5    31,7    11,8    72,9   0,950
AMY705       0,83     9 REGULAR              39,8    47,7    47,7    -0,0   100,0  -0,000
ZWW525       0,44     5 REGULAR              39,1    53,5    26.4    27,1    49,3   1,952
46577T       0,84     5 FORCE FIT            39,1    58,9    55,3     3,6    93,9   0,235
528DMB       0,74    19 REGULAR              39,8    27,3    29,7    -2,5   109,0  -0,268
550FDW       0,81     5 FORCE FIT            39,8    71,6    64,4     7,2    89,9   0,395
AUE429       0,87     7 REGULAR              40,4    41,1    41,2    -0,1   100,3  -0,011
033FDF       0,99     7 FORCE FIT            40,4    80,6    92,7   -12,0   114,9  -0,574
930GTY       0,75    13 REGULAR              41,1    26,1    25,3     0,8    97,0   0,106
965JVC       1,03    -1 REGULAR              39,8    25,5    26,5    -1,0   103,9  -0,168
873CDG       0,97     3 REGULAR              40,4    35,8    37,6    -1,7   104,9  -0,200
617HKS       1,22    13 BASELINE             41,8    19,1    30,2   -11,1   158,0  -2,054
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/12/74	A-13	MMA583	1963	VOLKSWAGON	POOR	NO	100	74	0,00	-0,05	75	78	5,4	0,050	7,53
STANDARD	8/12/74	A-14	751KNZ	1974		GOOD	NO	0	72	1,70	-0,05	75	76	5,9	0,790	5,45
STANDARD	8/12/74	A-15	62206	1971	VOLKSWAGON	POOR	NO	100	80	0,00	-0,20	75	78	9,6	0,320	5,24
STANDARD	8/12/74	B-16	NOB2	1974	CHEVROLET	POOR	NO	100	84	0,21	-0,20	75	79	20,1	0,030	6,03
STANDARD	8/12/74	A-17	MKR322	1965	FORD	GUOD	NO	0	92	0,00	-0,20	76	80	8,1	0,830	6,00
STANDARD	8/12/74	A-18	41354K	1972	JEEP	GOOD	NO	100	81	0,00	-0,20	76	79	14,3	1,190	5,80
STANDARD	8/12/74	A-18	516JTH	1973	PONTIAC	GOOD	NO	0	104	0,20	-0,20	76	80	13,8	0,870	5,63
STANDARD	8/12/74	A-19	G1170212	1973	PLYMOUTH	GOOD	NO	0	84	0,13	-0,20	76	80	15,3	1,880	5,77
STANDARD	8/12/74	A-19	E803228	1966	CHEVROLET	GOOD	NO	100	90	0,00	-0,05	76	80	14,6	0,940	5,84
STANDARD	8/12/74	A-20	636FCB	1972	FORD	GOOD	NO	0	88	0,00	0,00	76	80	2,9	0,300	5,27
STANDARD	8/12/74	A-21	P58930	1964	FORD	GOOD	NO	100	81	0,00	0,05	76	80	13,0	1,230	5,74
STANDARD	8/12/74	A-22	1JWY	1971	FORD	GOOD	NO	60	92	0,00	-0,20	76	80	10,6	1,080	5,40
STANDARD	8/12/74	A-23	095RGW	1972	FORD	GOOD	NO	20	83	0,00	0,10	76	80	5,4	0,920	5,79
STANDARD	8/12/74	A-24	434ACD	1969	VOLKSWAGON	GOOD	NO	100	86	0,00	-0,05	76	80	5,4	0,150	4,00
STANDARD	8/12/74	A-25	854JBV	1973	CHEVROLET	GOOD	NO	0	92	1,00	-0,20	76	80	16,3	2,010	5,62
STANDARD	8/12/74	A-26	712FXZ	1972		GOOD	NO	100	90	0,00	-0,05	76	85	9,2	1,110	5,69
STANDARD	8/12/74	A-27	932JWM	1973	DODGE	POOR	NO	100	84	0,00	-0,80	76	85	16,4	0,000	5,72
STANDARD	8/12/74	A-28	VYZ927	1970		GOOD	NO	0	88	0,00	-0,60	76	87	12,8	1,670	5,37
STANDARD	8/12/74	A-29	SNW426	1965	FORD	GOOD	NO	20	88	0,00	-0,05	78	87	11,2	0,640	-1,00
STANDARD	8/12/74	A-30	063106	1967	FORD	GOOD	NO	100	88	0,00	-0,60	78	85	19,7	1,800	4,10
STANDARD	8/12/74	A-31	69043V	1970	TOYOTA	GOOD	NO	0	90	0,00	-0,60	78	87	5,3	0,500	2,77
STANDARD	8/12/74	A-32	EB31318	1973	DODGE	GOOD	NO	0	103	-0,20	-0,60	80	87	14,7	1,400	5,40
STANDARD	8/12/74	A-33	654JVG	1974	CHEVROLET	POOR	NO	100	101	0,00	-0,60	80	89	7,4	0,410	4,48
STANDARD	8/12/74	A-34	119CGM	1971	CHEVROLET	GOOD	NO	0	97	0,25	-0,40	81	86	13,3	1,340	5,28
STANDARD	8/12/74	A-35	16DEW	1973	FORD	GOOD	NO	100	93	0,00	-0,60	83	87	14,1	1,300	5,72
STANDARD	8/12/74	A-36	CRUCK	1970	FORD	GOOD	NO	0	97	0,00	-0,40	83	87	5,4	0,810	5,23
STANDARD	8/12/74	B- 1	506EFU	1972	LINCOLN	GOOD	NO	0	77	0,95	0,24	76	68	17,9	2,695	6,97
STANDARD	8/12/74	B- 2	062EEZ	1972	MERCURY	GOOD	NO	0	79	0,00	0,21	74	70	16,3	2,241	5,75
STANDARD	8/12/74	B- 3	M53567	1962	CHEVROLET	GOOD	NO	100	73	0,00	0,20	75	73	9,6	1,415	5,24
STANDARD	8/12/74	B- 4	861JHO	1973	OPEL	POOR	NO	100	86	0,00	-0,08	76	72	6,8	0,259	8,16
STANDARD	8/12/74	B- 5	634AAL	1969	OLDSMOBILE	GOOD	NO	0	78	0,00	0,51	77	72	15,2	2,240	5,33
STANDARD	8/12/74	B- 6	UWN903	1967	VOLKSWAGON	GOOD	NO	100	82	0,00	-0,06	76	70	8,6	0,480	5,67
STANDARD	8/12/74	B- 7	531OXV	1969	VOLKSWAGON	GOOD	NO	100	79	0,00	0,23	75	71	5,4	0,560	5,14
STANDARD	8/12/74	B- 8	523JAV	1974		POOR	NO	100	81	0,00	0,09	75	71	19,0	2,300	5,51
STANDARD	8/12/74	B- 9	P20941	1963	FORD	GOOD	NO	0	84	0,00	0,30	77	72	15,2	1,590	5,18
STANDARD	8/12/74	B-10	RGS868	1960	FORD	GOOD	NO	100	80	0,00	0,03	74	70	6,3	0,320	4,97
STANDARD	8/12/74	B-11	582BGC	1970	CHEVROLET	GOOD	NO	0	75	0,65	0,23	74	71	8,3	1,040	5,30

LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
MMA583	0.06	-1	REGULAR	41.6	24.5	1.7	22.8	7.0	4.222
751KNZ	1.00	-3	FORCE FIT	40.4	26.7	26.3	0.5	98.2	0.080
62206	0.25	5	REGULAR	41.8	39.5	11.0	28.5	27.8	2.967
NOB2	0.01	9	FORCE FIT	42.5	78.2	1.0	77.2	1.3	3.840
MKR322	0.77	16	REGULAR	43.2	27.9	29.5	-1.6	105.7	-0.197
41354K	0.62	5	FORCE FIT	42.5	59.8	41.6	18.2	69.5	1.275
516JTH	0.47	28	FORCE FIT	43.2	35.3	30.9	4.4	87.5	0.319
G1170212	0.92	8	BASELINE	43.2	61.7	66.8	-5.1	108.2	-0.332
E803228	0.48	14	REGULAR	43.2	52.4	33.4	19.0	63.7	1.303
636FCB	0.77	12	REGULAR	43.2	10.8	10.7	0.2	98.3	0.062
P58930	0.71	5	REGULAR	43.2	55.3	43.7	11.6	79.0	0.892
1JWY	0.76	16	REGULAR	43.2	36.5	38.4	-1.9	105.1	-0.177
095BGW	1.27	7	REGULAR	43.2	22.2	32.7	-10.5	147.4	-1.945
434ACD	0.21	10	REGULAR	43.2	21.0	5.3	15.6	25.4	2.896
854JBV	0.92	16	BASELINE	43.2	56.1	71.4	-15.3	127.2	-0.937
712FXZ	0.90	14	REGULAR	46.9	35.9	42.8	-7.0	119.4	-0.756
932JWM	0.00	8	REGULAR	46.9	71.8	0.0	71.8	0.0	4.379
VYZ927	0.98	12	REGULAR	48.5	53.7	66.6	-12.9	124.0	-1.007
SNW425	0.43	10	FORCE FIT	48.5	48.9	25.5	23.3	52.3	2.082
Q63106	0.68	10	REGULAR	46.9	83.1	69.4	13.7	83.6	0.694
69043V	0.82	12	REGULAR	48.5	22.2	23.1	-0.9	104.0	-0.169
EB31318	0.71	23	FORCE FIT	48.5	48.3	55.8	-7.5	115.6	-0.512
654JVG	0.41	21	REGULAR	50.2	26.4	16.9	9.5	64.0	1.283
119CGM	0.75	16	FORCE FIT	47.7	50.6	52.6	-2.0	103.9	-0.150
16DEW	0.73	10	REGULAR	48.5	61.5	55.0	6.5	89.5	0.458
CRUCK	1.12	14	REGULAR	48.5	21.6	32.3	-10.5	148.4	-1.950
506EFU	1.13	1	BASELINE	35.4	66.7	78.4	-11.7	117.6	-0.656
062EEZ	1.03	5	REGULAR	36.6	58.7	67.4	-8.7	114.8	-0.534
M53567	1.10	-2	FORCE FIT	38.5	40.7	44.7	-4.0	109.8	-0.416
861JHQ	0.28	10	REGULAR	37.8	23.1	8.1	15.1	34.8	2.216
634AAL	1.10	1	FORCE FIT	37.8	60.5	69.6	-9.1	115.1	-0.601
UWN903	0.42	6	REGULAR	36.6	30.4	14.4	16.0	47.4	1.860
531DXV	0.78	4	FORCE FIT	37.2	20.1	17.1	3.0	85.1	0.554
523JAV	0.93	6	REGULAR	37.2	68.4	72.2	-3.8	105.6	-0.200
P20941	0.78	7	BASELINE	37.8	54.6	49.4	5.2	90.5	0.341
RGS868	0.38	6	REGULAR	36.6	22.3	9.6	12.7	43.2	2.011
582BGC	0.94	1	FORCE FIT	37.2	32.5	31.8	0.7	97.9	0.083

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP HDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/12/74	B-12	422FQP	1972	MERCURY	GOOD	NO	100	83	0.00	0.08	75	71	9.5	0.870	5.28
STANDARD	8/12/74	B-13	V59114	1967	FORD	GOOD	NO	0	79	0.00	0.15	74	70	12.0	1.580	5.29
STANDARD	8/12/74	B-14	KCH603	1966	CHEVROLET	GOOD	NO	100	80	0.00	0.08	75	70	14.9	1.480	8.28
STANDARD	8/12/74	B-15	894GEJ	1973		GOOD	NO	0	82	0.95	0.23	77	72	14.3	1.860	5.26
STANDARD	8/12/74	B-16	C44390	1962	CHEVROLET	GOOD	NO	100	80	0.00	0.09	76	72	13.0	1.100	5.78
STANDARD	8/12/74	B-17	158JWV	1974	DODGE	GOOD	NO	25	86	0.16	0.28	77	73	17.7	2.300	5.34
STANDARD	8/12/74	B-18	ZDF380	1969		POOR	NO	100	82	0.00	-0.20	76	73	18.7	0.960	6.72
STANDARD	8/12/74	B-19	512FDW	1972	DODGE	GOOD	NO	0	83	0.85	0.28	75	73	12.2	1.860	5.12
STANDARD	8/12/74	B-20	NAS581	1962	FORD	POOR	NO	100	84	0.00	0.01	75	73	5.4	0.500	3.95
STANDARD	8/12/74	B-21	967JWC	1974	OLDSMOBILE	GOOD	NO	0	92	0.40	0.14	76	74	5.4	0.410	5.23
STANDARD	8/12/74	B-22	774GET	1973	FORD	GOOD	NO	100	83	0.00	0.10	77	74	8.4	1.000	7.64
STANDARD	8/12/74	B-23	MMR934	1962	CHEVROLET	GOOD	NO	0	89	0.00	0.07	78	76	14.7	1.830	5.38
STANDARD	8/12/74	B-24	145EEF	1972	CHEVROLET	GOOD	NO	0	93	0.00	0.22	76	74	12.2	1.340	5.55
STANDARD	8/12/74	B-25	ER23454	1972		POOR	NO	100	0	0.00	0.11	77	75	13.3	1.260	6.60
STANDARD	8/12/74	B-26	U91369	19 0	FORD	GOOD	NO	100	83	0.00	-0.18	76	75	8.0	0.640	5.11
STANDARD	8/12/74	B-27	072JAW	1974	MERCURY	GOOD	NO	0	97	0.25	-0.22	77	79	22.8	2.130	5.34
STANDARD	8/12/74	B-28	135FWD	1972	MERCEDES	GOOD	NO	0	98	0.00	-0.06	79	80	9.3	0.880	5.37
STANDARD	8/12/74	B-29	67422K	1972	CHEVROLET	GOOD	NO	0	91	2.50	0.06	80	81	16.7	1.990	6.22
STANDARD	8/12/74	B-30	63951M	1973	DODGE	GOOD	NO	0	90	0.00	-0.01	79	80	12.5	1.280	5.38
STANDARD	8/12/74	B-31	109FHJ	1972	MERCURY	GOOD	NO	0	100	0.00	-0.22	81	80	14.5	1.250	7.98
STANDARD	8/12/74	B-32	199AHF	1970		GOOD	YES	10	92	0.00	0.10	82	80	12.2	1.520	5.55
STANDARD	8/12/74	B-33	WDW143	1968	BUICK	GOOD	NO	80	95	0.00	-0.16	82	80	15.6	1.320	5.60
STANDARD	8/12/74	B-34	KPD240	1966	CHEVROLET	GOOD	NO	100	99	0.00	0.11	82	79	16.4	1.430	6.07
STANDARD	8/12/74	B-35	63899M	1973	DODGE	GOOD	NO	0	85	2.20	0.29	81	79	14.6	1.930	7.06
STANDARD	8/13/74	A- 1	MTN847	1965	FORD	GOOD	NO	100	67	0.00	-0.05	75	60	16.0	1.820	5.61
STANDARD	8/13/74	A- 2	842FSU	1973	FORD	GOOD	NO	0	81	0.00	-0.02	79	65	8.4	0.860	4.75
STANDARD	8/13/74	A- 3	201MHE	1972	DODGE	GOOD	NO	0	72	0.00	0.01	80	68	12.6	2.040	5.73
STANDARD	8/13/74	A- 4	209KTG	1974		GOOD	NO	0	0	0.00	-0.01	79	64	5.4	0.810	8.53
STANDARD	8/13/74	A- 5	009KEY	1973	VOLKSWAGON	POOR	NO	100	79	0.00	-0.02	79	64	6.8	0.390	4.58
STANDARD	8/13/74	A- 6	ORR619	1964	DODGE	GOOD	NO	0	77	0.00	-0.05	80	70	11.9	1.410	9.27
STANDARD	8/13/74	A- 7	978HAO	1973	CHEVROLET	GOOD	NO	0	88	0.00	-0.05	79	68	13.9	1.510	5.79
STANDARD	8/13/74	A- 8	SNX940	1961	VOLKSWAGON	GOOD	NO	0	75	0.00	-0.05	79	68	7.4	0.970	5.55
STANDARD	8/13/74	A- 9	93274M	1971	GMC	GOOD	NO	0	82	0.00	0.00	80	68	12.2	1.540	5.76
STANDARD	8/13/74	A-10	904HLF	1973	FORD	GOOD	NO	0	83	0.02	-0.02	79	68	7.7	0.850	4.40
STANDARD	8/13/74	A-11	617HKS	1974		GOOD	NO	100	78	0.00	-0.02	78	67	5.4	0.860	8.53
STANDARD	8/13/74	A-12	786JAV	1966	FORD	GOOD	NO	100	77	0.00	-0.05	80	69	5.4	0.700	5.40
STANDARD	8/13/74	A-13	WPT476	1968		GOOD	NO	100	75	0.00	-0.05	80	68	10.2	1.080	5.61

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LICENSE    VAPOR  DELTA  VEHICLE             SAT    BASE    ACT    AMT    HC X     HC
           LIQUID TEMP   DESIGNATION          HC     RET    RET     HC    RECV  EMISS
           RATIO                            CONC      HC     HC   LOST    BASE GM/GAL
022FQP      0.69      8  REGULAR            37.2    33.0   26.6    6.4    80.7  0.671
V59114      0.96      5  FORCE FIT          36.6    43.2   47.5   -4.3   110.0 -0.359
RCH603      0.74      5  REGULAR            36.6    53.7   44.5    9.1    83.0  0.614
894GEJ      0.97      5  BASELINE           37.8    53.2   57.8   -4.6   108.6 -0.321
C40390      0.83      4  REGULAR            37.8    49.2   34.2   15.0    69.5  1.150
158JWV      0.97      9  FORCE FIT          38.5    62.4   72.7  -10.4   116.6 -0.508
ZDF380      0.38      6  REGULAR            38.5    69.6   30.3   39.2    43.6  2.090
512FDW      1.14      8  BASELINE           38.5    43.8   58.8  -15.0   134.3 -1.231
NAS581      0.69      9  REGULAR            38.5    19.0   15.8    3.2    83.1  0.590
967JWC      0.57     16  FORCE FIT          39.1    16.8   13.2    3.6    78.3  0.675
774GEI      0.89      6  REGULAR            39.1    31.8   32.1   -0.4   101.2 -0.045
MMR934      0.93     11  BASELINE           40.4    52.4   60.8   -8.4   116.0 -0.572
145EEF      0.82     17  REGULAR            39.1    37.2   43.1   -5.9   115.8 -0.482
E823054     0.71    -77  INST. FAIL.        39.8   125.9   41.2   84.8    32.7  6.374
U91369      0.66      7  REGULAR            39.8    30.2   20.9    9.3    69.2  1.163
072JAW      0.70     20  FORCE FIT          42.5    70.6   74.4   -3.8   105.4 -0.167
135EWD      0.71     19  REGULAR            43.2    30.0   31.2   -1.3   104.3 -0.139
67422K      0.89     11  BASELINE           43.9    64.7   71.8   -7.2   111.1 -0.429
63951M      0.77     11  REGULAR            43.2    47.6   45.5    2.2    95.4  0.174
109FHJ      0.54     19  BASELINE           43.2    46.7   44.4    2.3    95.0  0.159
199ARF      0.93     10  REGULAR            43.2    47.4   54.0   -6.6   113.9 -0.541
WOW143      0.63     13  FORCE FIT          43.2    57.1   46.9   10.3    82.0  0.658
KPD240      0.65     17  REGULAR            42.5    54.3   49.9    4.4    91.9  0.267
63899M      0.99      4  BASELINE           42.5    62.1   67.4   -5.3   108.5 -0.363
MIN847      0.85     -8  REGULAR            31.0    59.8   46.4   13.4    77.5  0.839
842FSU      0.77      2  REGULAR            33.7    29.3   23.8    5.5    81.3  0.652
201MBE      1.21     -8  REGULAR            35.4    53.8   59.3   -5.6   110.4 -0.442
209KTG      1.12    -79  INST. FAIL.        33.1    43.2   22.1   21.2    51.0  3.918
009KEY      0.43      0  REGULAR            33.1    24.1   10.6   13.5    44.1  1.980
ORR619      0.89     -3  REGULAR            36.6    48.8   42.4    6.4    86.9  0.537
978HAD      0.81      9  REGULAR            35.4    45.1   43.9    1.1    97.5  0.081
SNX940      0.98     -4  FORCE FIT          35.4    29.8   28.2    1.6    94.7  0.213
03274M      0.94      2  REGULAR            35.4    44.7   44.8   -0.1   100.2 -0.008
904MLE      0.83      4  BASELINE           35.4    27.3   24.7    2.6    90.6  0.332
617HKS      1.19      0  REGULAR            34.6    20.1   24.6   -4.5   122.4 -0.834
786JAV      0.97     -3  FORCE FIT          36.0    21.8   20.7    1.1    95.1  0.198
WPT476      0.79     -5  REGULAR            35.4    41.7   31.4   10.3    75.4  1.008
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT HAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/13/74	A-14	68HHHZ	1973	FORD	GOOD	NO	0	75	0.24	-0.05	80	70	7.2	0.840	5.47
STANDARD	8/13/74	A-15	907GDS	1972	CHEVROLET	POOR	NO	0	86	0.00	-0.05	80	70	8.6	0.880	5.61
STANDARD	8/13/74	A-16	468FQG	1972	FORD	GOOD	NO	0	84	1.40	-0.10	80	71	8.4	1.050	6.63
STANDARD	8/13/74	A-17	732CWR	1971	PLYMOUTH	POOR	NO	60	83	0.00	-0.30	83	75	9.0	0.570	4.19
STANDARD	8/13/74	A-18	65439N	1973	FORD	POOR	YES	100	87	0.00	-0.10	83	76	14.7	1.000	5.31
STANDARD	8/13/74	A-19	106HBZ	1973	VOLKSWAGON	POOR	NO	100	87	0.00	-0.20	80	76	5.4	0.250	5.23
STANDARD	8/13/74	A-20		1973	VOLKSWAGON	POOR	NO	100	90	0.00	-0.10	83	76	10.1	0.330	3.54
STANDARD	8/13/74	A-21	095BGK	1970	FORD	GOOD	NO	100	86	0.70	-0.05	80	77	12.0	1.640	5.81
STANDARD	8/13/74	A-22	201AFQ	1969	VOLKSWAGON	GOOD	NO	0	87	0.00	-0.30	80	83	7.6	0.590	5.30
STANDARD	8/13/74	A-23	640KCD	1974	FORD	GOOD	NO	0	90	0.00	-0.20	83	82	8.7	1.150	5.55
STANDARD	8/13/74	A-24	636FCP	1972	FORD	GOOD	NO	0	102	0.00	-0.60	85	85	5.4	0.310	3.60
STANDARD	8/13/74	A-25	63277M	1973	CHEVROLET	GOOD	NO	0	86	0.00	-0.40	83	80	8.3	2.720	1.81
STANDARD	8/13/74	A-26	YLZ244	1969	RAMBLER	POOR	NO	100	96	0.00	-0.70	82	80	7.6	0.360	5.77
STANDARD	8/13/74	B- 1	60350M	1973	CHEVROLET	GOOD	NO	0	73	0.00	-0.03	76	63	12.7	1.750	5.44
STANDARD	8/13/74	B- 2	57103A	1968	DODGE	GOOD	NO	0	70	0.00	-0.05	73	66	14.8	1.900	5.19
STANDARD	8/13/74	B- 3	NAT648	1961	PEUGEOT	POOR	YES	100	64	0.00	-0.18	73	68	11.9	0.670	8.81
STANDARD	8/13/74	B- 4	226ADG	1970	VOLKSWAGON	POOR	NO	100	64	0.00	-0.10	70	67	8.6	1.050	5.43
STANDARD	8/13/74	B- 5	4BVY	1971	CHEVROLET	POOR	NO	100	69	0.00	-0.15	70	67	11.9	0.430	5.67
STANDARD	8/13/74	B- 6	342JWC	1974		GOOD	NO	0	77	0.55	0.05	75	75	16.1	1.990	7.00
STANDARD	8/13/74	B- 7	062FEZ	1972	MERCURY	GOOD	NO	0	82	0.00	0.14	73	75	12.0	1.430	10.29
STANDARD	8/13/74	B- 8	937JBV	1974	BUICK	GOOD	NO	0	75	2.55	0.33	75	72	18.6	2.090	10.73
STANDARD	8/13/74	B- 9	EBH793	1966	DODGE	GOOD	NO	100	74	0.00	-0.10	73	73	12.7	0.930	5.73
STANDARD	8/13/74	B-10	498JWD	1974	VOLKSWAGON	POOR	NO	100	74	0.00	-0.10	74	72	7.1	0.180	8.04
STANDARD	8/13/74	B-11	3202HG	1970	DODGE	GOOD	NO	100	77	0.00	0.13	76	72	14.1	1.050	5.46
STANDARD	8/13/74	B-12	2801HM	1974	CHEVROLET	GOOD	NO	0	80	0.24	0.23	77	75	12.2	1.460	5.46
STANDARD	8/13/74	B-13	280LCD	1974		GOOD	NO	100	82	0.00	0.05	76	77	43.3	4.970	6.53
STANDARD	8/13/74	B-14	973CGK	1973		GOOD	NO	0	86	0.85	0.11	76	77	9.8	1.100	5.30
STANDARD	8/13/74	B-15	027EEY	1972	PONTIAC	POOR	NO	60	79	0.00	-0.07	77	77	10.4	1.380	5.39
STANDARD	8/13/74	B-16	253KUA	1974	FORD	GOOD	NO	0	83	1.15	0.23	78	77	5.4	0.740	4.34
STANDARD	8/13/74	B-17	33530S	1973	FORD	GOOD	NO	100	84	0.00	0.16	78	77	9.8	0.980	5.07
STANDARD	8/13/74	B-18	334FDG	1972	FORD	GOOD	NO	100	80	0.00	0.25	84	79	17.0	2.250	5.43
STANDARD	8/13/74	B-19	626JBS	1974	CHEVROLET	GOOD	NO	0	84	0.00	0.12	83	82	16.0	1.620	5.61
STANDARD	8/13/74	B-20	NFG50B	1965	DODGE	GOOD	NO	0	98	0.00	-0.08	83	81	9.1	0.780	6.00
STANDARD	8/13/74	B-21	033[illegible]	1966	VOLKSWAGON	GOOD	NO	100	81	0.00	0.14	83	81	4.7	0.480	5.32
STANDARD	8/13/74	B-22	357F[illegible]	1973	PONTIAC	GOOD	NO	80	92	0.45	0.15	83	80	9.1	0.920	5.52
STANDARD	8/13/74	B-23	04117V	1972	FORD	GOOD	NO	100	85	0.00	0.16	83	81	8.3	0.800	5.24
STANDARD	8/13/74	B-24	422LF[illegible]	1974	PLYMOUTH	GOOD	NO	0	88	0.65	-0.18	86	82	7.9	1.040	5.39

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LICENSE   VAPOR  DELTA  VEHICLE            SAT   BASE    ACT    AMT   HC %    HC
          LIQUID TEMP   DESIGNATION         HC    RET    RET     HC   RECV  EMISS
           RATIO                          CONC     HC     HC   LOST   BASE  GM/GAL
688HBZ      0.87    -5 BASELINE           36.6   30.4   25.3    5.2   83.1  0.715
907GDS      0.77     6 REGULAR            36.6   30.4   26.5    4.0   87.0  0.402
468FQG      0.94     4 FORCE FIT          37.2   31.3   32.1   -0.8  102.6 -0.097
732CWR      0.47     0 REGULAR            39.8   38.3   18.6   19.6   48.7  2.102
66439N      0.51     4 REGULAR            40.4   59.5   33.2   26.3   55.8  1.787
106HBZ      0.35     7 REGULAR            40.4   20.7    8.3   12.4   40.1  2.302
            0.24     7 REGULAR            40.4   38.8   11.0   27.8   28.3  2.785
095BGW      1.02     0 REGULAR            41.1   47.7   55.4   -7.7  116.2 -0.843
201AFQ      0.58     7 FORCE FIT          45.4   32.8   22.0   10.8   67.1  1.417
640KCO      0.99     7 REGULAR            44.7   36.9   42.2   -5.3  114.4 -0.610
636FCB      0.43    17 REGULAR            46.9   19.8   12.0    7.8   60.5  1.446
63277M      2.45     3 REGULAR            43.8   36.5   96.6  -60.1  264.5 -7.230
YLZ244      0.35    14 FORCE FIT          43.2   27.3   12.8   14.5   46.9  1.986
60350M      1.03    -3 REGULAR            32.6   46.4   46.9   -0.5  101.1 -0.048
57103A      0.96    -3 REGULAR            34.2   56.8   53.5    3.3   94.2  0.223
NAT640      0.42    -9 BAD READING        35.4   51.5   19.5   32.0   37.8  2.690
226ADG      0.91    -6 FORCE FIT          34.8   35.1   30.0    5.0   85.7  0.585
48VY        0.27    -1 REGULAR            34.8   45.0   12.3   32.7   27.3  2.748
342JWC      0.92     2 BASELINE           39.8   66.3   65.0    1.2   98.1  0.076
062EEZ      0.89     9 REGULAR            39.8   43.7   46.7   -3.0  106.9 -0.253
937JBV      0.84     0 BASELINE           37.8   75.2   65.0   10.3   86.4  0.551
EBH793      0.55     1 REGULAR            38.5   51.4   29.4   22.0   57.2  1.732
498JWD      0.19     0 FORCE FIT          37.8   28.7    5.6   23.1   19.5  3.257
32028G      0.56     1 REGULAR            37.8   56.1   32.6   23.5   58.2  1.665
280LBM      0.90     3 BASELINE           39.8   49.4   47.7    1.7   96.6  0.137
280LCQ      0.86     6 REGULAR            41.1  172.1  167.9    4.2   97.6  0.097
973CGK      0.84    10 BASELINE           41.1   36.2   37.2   -1.0  102.6 -0.097
027EEY      0.56     2 REGULAR            41.1   78.3   46.6   31.7   59.5  1.721
253KUA      1.03     7 BASELINE           41.1   21.1   25.0   -3.9  118.6 -0.725
33539S      0.75     6 REGULAR            41.1   39.0   33.1    5.8   85.0  0.596
334EDG      0.99    -4 REGULAR            42.5   82.2   78.6    3.6   95.6  0.211
626JBG      0.76     1 REGULAR            44.7   75.2   59.5   15.7   79.1  0.983
NEG508      0.64    15 FORCE FIT          43.9   32.5   28.2    4.4   86.6  0.479
833DXV      0.76    -2 REGULAR            43.9   22.8   17.3    5.4   76.1  1.159
357FMU      0.76     9 FORCE FIT          43.2   36.0   32.7    3.3   90.7  0.367
04117V      0.72     2 REGULAR            43.9   37.7   28.9    8.9   76.5  1.067
422LFW      0.98     2 FORCE FIT          44.7   36.5   38.2   -1.7  104.5 -0.209
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/13/74	B-25	4A8ARP	1970	PLYMOUTH	GOOD	NO	100	0	0.00	0.15	83	82	8.3	1.010	5.86
STANDARD	8/13/74	B-26	WA6KNX	1973	CHEVROLET	GOOD	NO	0	94	0.12	0.15	83	83	6.6	0.790	5.28
STANDARD	8/13/74	B-27	025JAK	1974	FORD	GOOD	NO	100	93	0.00	0.13	84	86	10.5	1.060	5.00
STANDARD	8/14/74	A- 1	317ARM	1965	PLYMOUTH	POOR	NO	45	94	0.00	-0.05	75	83	9.4	0.330	5.32
STANDARD	8/14/74	A- 2	201LCD	1974	BUICK	GOOD	NO	0	104	0.90	-0.05	83	84	6.4	0.310	6.00
STANDARD	8/14/74	A- 3	617HKS	1973	MERCURY	GOOD	NO	0	89	0.00	0.10	83	84	5.4	0.900	7.71
STANDARD	8/14/74	A- 4	699JBB	1972	FORD	POOR	NO	100	88	0.00	-0.05	83	84	5.4	0.510	5.31
STANDARD	8/14/74	A- 5	365HBZ	1973	DATSUN	GOOD	NO	100	96	0.00	-0.05	83	84	5.4	0.570	4.63
STANDARD	8/14/74	A- 6	JHE168	1972		GOOD	NO	0	99	-0.10	-0.10	84	88	20.5	1.040	5.30
STANDARD	8/14/74	A- 7	19245	1972	PONTIAC	GOOD	NO	10	117	0.00	-0.40	84	92	11.9	1.230	5.58
STANDARD	8/14/74	A- 8	999KTP	1974	FORD	GOOD	NO	0	96	0.40	0.05	85	97	5.4	0.460	5.06
STANDARD	8/14/74	A- 9	4U582	1974	DATSUN	POOR	NO	100	97	0.00	0.05	83	95	6.4	0.500	3.80
STANDARD	8/14/74	A-10	LX8060	1973	FORD	GOOD	NO	0	98	0.40	0.10	85	97	8.8	1.050	5.58
STANDARD	8/14/74	A-11	056HXM	1973	OLDMOBILE	GOOD	NO	0	119	0.00	0.10	83	97	11.8	0.270	5.53
STANDARD	8/14/74	A-12	V58520	1966	CHEVROLET	GOOD	NO	100	95	0.00	0.05	83	95	6.2	0.810	7.02
STANDARD	8/14/74	A-13	905HBX	1973	OLDSMOBILE	GOOD	NO	100	103	0.00	0.05	83	98	16.7	1.070	5.60
STANDARD	8/14/74	A-14	467DVQ	1968	VOLKSWAGON	GOOD	NO	0	95	0.00	0.20	83	97	8.3	1.160	4.05
STANDARD	8/14/74	A-15	WDH856	1968	DODGE	GOOD	NO	0	99	0.00	0.01	83	98	4.8	0.430	5.33
STANDARD	8/14/74	A-16	0424WU	1973	FORD	GOOD	NO	0	96	0.80	0.05	84	96	8.8	1.050	5.11
STANDARD	8/14/74	A-17	WDW449	1969	DODGE	GOOD	NO	0	95	0.00	0.05	84	97	9.6	1.150	5.24
STANDARD	8/14/74	A-18	YLX423	1969	PLYMOUTH	GOOD	NO	0	97	0.00	0.01	84	97	15.7	1.600	5.32
STANDARD	8/14/74	A-19	015CDV	1960	PLYMOUTH	POOR	NO	100	94	0.00	-0.10	84	98	10.7	0.140	5.22
STANDARD	8/14/74	A-20	YAM267	1968	AUS HEALEY	GOOD	NO	65	102	0.00	-0.05	84	98	6.1	0.500	5.55
STANDARD	8/14/74	A-21	462CNC	1971	VOLKSWAGON	GOOD	NO	0	91	0.00	0.05	84	98	5.4	0.800	4.78
STANDARD	8/14/74	A-22	122AXU	1970	VOLKSWAGON	GOOD	NO	100	93	0.00	0.05	85	95	8.8	1.050	5.37
STANDARD	8/14/74	A-23	181HKM	1973	MERCURY	GOOD	NO	100	0	0.00	0.05	84	98	15.0	0.910	5.33
STANDARD	8/14/74	A-24	HGD198	1973	CADILLAC	GOOD	NO	0	94	0.50	0.20	84	94	21.9	2.300	5.32
STANDARD	8/14/74	B- 1	309518	1968	CHEVROLET	GOOD	NO	100	90	0.00	-0.05	76	77	12.0	1.200	5.14
STANDARD	8/14/74	B- 2	XOK313	1968	VOLKSWAGON	GOOD	NO	100	87	0.00	-0.08	77	78	5.1	0.560	5.28
STANDARD	8/14/74	B- 3	994JWC	1968	VOLKSWAGON	GOOD	NO	100	88	0.00	0.03	77	80	5.4	0.530	7.71
STANDARD	8/14/74	B- 4	323HBE	1970		POOR	NO	100	103	0.00	-0.30	77	79	13.1	1.240	8.36
STANDARD	8/14/74	B- 5	109EEZ	1971	VOLKSWAGON	POOR	NO	100	91	0.00	-0.10	79	81	7.6	0.730	5.70
STANDARD	8/14/74	B- 6	624GKH	1973	FORD	GOOD	NO	0	97	1.50	-0.10	79	80	4.1	0.400	5.02
STANDARD	8/14/74	B- 7	056KNX	1973	CHEVROLET	POOR	YES	100	105	0.00	1.05	80	80	4.5	0.860	6.28
STANDARD	8/14/74	B- 8	V283	1968	VOLKSWAGON	GOOD	NO	0	90	0.00	0.04	79	81	7.1	0.910	5.46
STANDARD	8/14/74	B- 9	SPM507	1966	MERCUR0	GOOD	NO	20	94	0.00	-0.14	79	2	6.3	0.800	4.97
STANDARD	8/14/74	B-10	509EEV	1972	IH	GOOD	NO	0	92	2.10	-0.22	80	81	14.7	1.700	5.16

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LICENSE   VAPOR  DELTA  VEHICLE           SAT    BASE    ACT     AMT    HC %    HC
          LIQUID TEMP   DESIGNATION        HC     RET     RET     HC    RECV   EMISS
          RATIO                           CONC    HC      HC     LOST   BASE  GM/GAL
488ARR     0.91   -83 INST. FAIL.         44.7    92.1    37.1   55.0    40.3  6.627
WA6KNX     0.90    11 BASELINE            45.4    26.4    29.5   -3.1   111.6 -0.463
025JAW     0.76     9 REGULAR             47.7    45.9    41.6    4.3    90.6  0.411
317ARM     0.26    19 REGULAR             45.4    31.8    12.3   19.5    38.7  2.075
201LCD     0.36    21 BASELINE            46.2    21.0    11.8    9.3    55.9  1.447
617HKS     1.36     6 REGULAR             46.2    24.1    37.2  -13.1   154.2 -2.422
699JBB     0.71     5 REGULAR             46.2    24.5    19.4    5.2    78.9  0.959
366HRZ     0.79    13 REGULAR             46.2    21.1    21.6   -0.5   102.4 -0.092
JHE168     0.38    15 BASELINE            49.3    82.3    42.2   40.1    51.2  1.957
19245      0.77    33 REGULAR             52.7    31.8    53.3  -21.5   167.6 -1.807
999KTP     0.64    11 BASELINE            57.3    27.3    21.7    5.6    79.4  1.041
4U562      0.58    14 REGULAR             55.4    29.5    22.8    6.7    77.3  1.045
LX805W     0.89    13 BASELINE            57.3    42.7    49.4   -6.7   115.7 -0.762
056HXM     0.17    36 REGULAR             57.3    30.8    12.7   18.1    41.3  1.533
V58520     0.98    12 REGULAR             55.4    29.7    36.9   -7.2   124.1 -1.157
905HBX     0.48    20 REGULAR             58.2    70.9    51.2   19.6    72.3  1.175
467DVQ     1.05    12 FORCE FIT           57.3    41.1    54.6  -13.5   132.8 -1.626
WDH856     0.67    16 REGULAR             56.2    22.3    20.6    1.7    92.4  0.352
0424RU     0.91    12 BASELINE            56.3    41.9    48.6   -6.7   116.0 -0.782
WDH449     0.90    11 REGULAR             57.3    48.5    54.2   -5.7   111.7 -0.590
YLX423     0.79    13 REGULAR             57.3    76.3    78.2   -1.9   102.5 -0.122
015CDY     0.09    10 REGULAR             56.2    56.0     6.7   49.3    12.0  4.610
YAM267     0.71    18 REGULAR             58.2    27.1    27.8   -0.7   102.5 -0.111
462CNC     1.11     7 REGULAR             56.3    28.9    37.1   -8.1   128.2 -1.509
122AXU     0.91     8 REGULAR             55.4    44.5    47.8   -3.4   107.6 -0.391
181HKM     0.45   -84 INST. FAIL.         58.2   218.5    43.6  175.0    19.9 11.663
HGD19H     0.79    10 BASELINE            54.5   107.3   103.0    4.3    96.0  0.194
309518     0.75    14 REGULAR             41.1    41.0    40.5    0.4    98.9  0.036
XQK313     0.82    10 FORCE FIT           41.8    19.2    19.2   -0.0   100.4 -0.015
994JWC     0.73    11 REGULAR             43.2    20.6    18.8    1.8    91.5  0.325
323HBE     0.71    26 FORCE FIT           42.5    34.9    43.3   -8.5   124.2 -0.645
109EEZ     0.72    12 REGULAR             43.9    28.9    26.4    2.5    91.3  0.331
624GKH     0.73    18 BASELINE            43.2    13.5    14.2   -0.7   105.2 -0.170
056KNX     0.10    25 REGULAR             43.2    12.5     2.1   10.4    17.0  2.305
V283       0.96    11 FORCE FIT           43.9    27.5    32.9   -5.4   119.5 -0.754
SPM597     0.95    15 REGULAR             11.8     6.1     7.8   -1.7   128.3 -0.272
589EEV     0.90    12 FORCE FIT           43.9    55.8    63.5   -7.7   113.8 -0.524
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STATION    DATE    TEST LICENSE  YEAR   MAKE        TYPE SPT EXP VEH  VEH   SYS  GAS VAP AMT   VOL    DISP
                    NO                               OF  BAK RDG  TK   TK   PRES  TMP TMP GAS   VAP    RATE
                                                    FIT          TMP  PRES                     DISP
STANDARD  8/14/74 B-11 268JND   1974 FORD         GOOD NO    0  96  0.00 -0.14 83  90   8.2  0.970   5.23
STANDARD  8/14/74 B-12 H66635   1960 CHEVROLET    GOOD NO   20  95  0.00 -0.05 87  95   5.4  0.780   5.23
STANDARD  8/14/74 B-13 UFH940   1967 VOLKSWAGON   POOR NO   60  96  0.00 -0.26 87  90   5.9  0.760   5.28
STANDARD  8/14/74 B-14 617HKS   1973 MERCURY      GOOD NO    0  99  0.22  0.05 85  87   5.4  0.570   4.80
STANDARD  8/14/74 B-15 5HBY     1973 DATSUN       POOR NO  100  99  0.00 -0.19 83  87   9.6  0.780   4.43
STANDARD  8/14/74 B-16 POM911   1961 PLYMOUTH     POOR NO  100  99  0.00 -0.11 87  86  11.8  0.000   5.13
STANDARD  8/14/74 B-17 K42691   1950 FORD         POOR NO  100  94  0.00 -0.09 87  86  17.9  1.530   4.30
STANDARD  8/14/74 B-18 MRF237   1961 CHEVROLET    GOOD NO  100   0  0.00  0.02 84  85  14.5  1.400   5.50
STANDARD  8/14/74 B-19 VML569   1967 RAMBLER      POOR NO  100  95  0.00 -0.11 84  87  11.8  0.090   5.45
STANDARD  8/14/74 B-20 06089U   1973 CHEVROLET    POOR NO  100  99  0.00  0.01 87  86   7.8  0.000   4.37
STANDARD  8/14/74 B-21 390316   1970 GMC          GOOD NO  100  89  0.00  0.06 87  87  12.3  1.000   5.39
STANDARD  8/14/74 B-22 MMK565   1968 PLYMOUTH     GOOD NO  100  90  0.00  0.13 84  87  15.0  1.470  10.71
STANDARD  8/14/74 B-23 448FFK   1972 JEEP         GOOD NO    0  97  0.00  0.07 85  87  13.6  1.000   5.13
STANDARD  8/14/74 B-24 N64762   1964 GMC          GOOD NO  100  93  0.00  0.05 85  88   8.3  0.760   5.30
STANDARD  8/14/74 B-25 K86655   1961 CHEVROLET    GOOD NO  100  94  0.00  0.08 85  87   7.3  0.570   5.40
STANDARD  8/14/74 B-26 309GES   1973 FORD         GOOD NO    0  98  0.05 -0.14 85  87   7.0  0.550   5.19
STANDARD  8/14/74 B-27 207GTU   1973 FORD         GOOD NO    0  98  0.00  0.05 84  86  18.6  1.220   5.21
STANDARD  8/14/74 B-28 EDG067   1957 CHEVROLET    GOOD NO  100  90  0.00  0.15 82  84   5.4  0.400   5.79
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LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
268JND	0.88	13	REGULAR	51.0	35.5	40.7	-5.2	114.7	-0.635
H66635	0.97	8	FORCE FIT	55.4	27.9	31.9	-4.0	114.2	-0.734
UFM948	0.96	9	REGULAR	51.0	27.6	31.9	-4.3	115.6	-0.729
617HKS	0.79	14	BASELINE	48.5	21.8	22.7	-1.0	104.4	-0.179
5HRY	0.59	15	REGULAR	48.5	37.1	30.3	6.8	81.7	0.708
PDM911	0.05	12	FORCE FIT	47.7	48.7	3.1	45.6	6.4	3.861
K42691	0.64	7	REGULAR	47.7	81.2	60.0	21.1	74.0	1.181
MRF237	4.76	-84	INST. FAIL.	46.9	170.2	57.1	113.1	33.5	7.802
VML569	0.06	11	REGULAR	45.5	50.5	3.6	46.9	7.1	3.975
06P89U	0.90	12	FORCE FIT	47.7	32.2	0.0	32.2	0.0	4.127
39031G	0.66	2	REGULAR	48.5	61.8	43.1	18.7	69.7	1.521
WMK565	0.73	6	FORCE FIT	48.5	70.4	58.6	11.8	83.3	0.784
448EFK	0.88	12	REGULAR	48.5	57.1	63.8	-6.7	111.6	-0.496
N64762	0.68	8	FORCE FIT	49.3	38.2	30.8	7.4	80.7	0.890
K86655	0.58	9	REGULAR	48.5	32.4	22.7	9.7	70.1	1.330
309GES	0.59	13	BASELINE	48.5	28.8	21.9	6.9	76.2	0.980
207GTU	0.49	14	REGULAR	47.7	73.7	47.9	25.9	64.9	1.392
FDG867	0.55	8	FORCE FIT	46.2	23.3	15.2	8.1	65.3	1.496

STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/15/74	A- 1	663FFK	1972		GOOD	NO	0	74	0,00	0,00	80	75	14,9	1,390	7,27
STANDARD	8/15/74	A- 2	853JT7	1973	MERCEDES	POOR	NO	10	82	0,00	-0,40	80	78	15,2	1,350	4,15
STANDARD	8/15/74	A- 3	ER0322A	1968	CHEVROLET	GOOD	NO	0	83	0,00	-0,60	85	84	15,2	1,380	5,85
STANDARD	8/15/74	A- 4	693JA*	1974	DATSUN	GOOD	NO	100	73	0,00	-0,40	82	81	8,5	1,060	8,23
STANDARD	8/15/74	A- 5	145J2F	1973	OLDSMOBILE	GOOD	NO	100	82	0,00	-0,50	80	80	6,3	0,910	5,64
STANDARD	8/15/74	A- 6	544CLT	1971	CHEVROLET	GOOD	NO	0	84	0,55	-0,80	82	80	7,4	0,710	3,96
STANDARD	8/15/74	A- 7	105HB7	1973	VOLKSWAGON	POOR	NO	100	76	0,00	-1,40	82	80	8,1	0,020	5,65
STANDARD	8/15/74	A- 8	513JAY	1973	CHEVROLET	GOOD	NO	0	84	-0,10	-0,80	82	83	18,4	1,950	5,39
STANDARD	8/15/74	A- 9	368FRI	1972	OLDSMOBILE	POOR	NO	100	90	0,00	-0,80	82	84	11,2	0,460	4,15
STANDARD	8/15/74	A-10	538FDQ	1972	FORD	GOOD	NO	0	81	0,00	-0,80	83	82	5,4	0,570	6,23
STANDARD	8/15/74	A-11	1552IN	1973	FORD	GOOD	NO	0	80	0,00	-0,90	83	82	17,1	2,040	7,28
STANDARD	8/15/74	A-12	XZP59A	1960	MRRS COOPR	POOR	NO	100	87	0,00	-1,00	83	80	6,1	0,440	4,18
STANDARD	8/15/74	A-13	ZUY00B	1968	VOLKSWAGON	GOOD	NO	100	76	0,00	0,00	83	82	6,9	0,410	4,93
STANDARD	8/15/74	A-14	254LBF	1974	FORD	GOOD	NO	0	82	-0,20	-0,80	83	83	13,4	2,100	5,32
STANDARD	8/15/74	A-15	STJ314	1974	VOLKSWAGON	GOOD	NO	100	0	0,00	0,80	84	92	7,6	0,370	5,18
STANDARD	8/15/74	A-16	871A60	1955	FORD	GOOD	NO	5	82	0,00	-0,40	85	92	9,1	0,920	5,57
STANDARD	8/15/74	A-17	765AXC	1970	FORD	POOR	YES	100	81	0,00	-1,80	85	91	20,0	1,670	7,32
STANDARD	8/15/74	A-18	RLH603	1966	CHEVROLET	GOOD	NO	100	91	0,00	-0,40	85	90	5,4	0,510	5,49
STANDARD	8/15/74	A-19	095RGW	1970	CHEVROLET	GOOD	NO	0	85	0,00	0,05	85	90	4,7	0,600	3,53
STANDARD	8/15/74	A-20	294FSZ	1972	CHEVROLET	GOOD	NO	0	93	-0,20	-0,30	85	90	5,3	0,620	5,39
STANDARD	8/15/74	A-21	193HCJ	1973	FIAT	GOOD	NO	0	89	0,00	-0,05	86	92	6,5	0,690	5,27
STANDARD	8/15/74	A-22	MNC554	1955	DODGE	POOR	NO	100	84	0,00	-0,80	85	90	14,2	0,670	5,72
STANDARD	8/15/74	A-23	E551741	1970	DODGE	GOOD	NO	0	94	0,00	-0,05	85	90	15,6	1,660	5,38
STANDARD	8/15/74	A-24	474FQV	1968	BUICK	GOOD	NO	0	94	0,00	-0,40	85	92	16,7	1,330	5,80
STANDARD	8/15/74	A-25	1400783	1974	FORD	GOOD	NO	0	97	0,00	-0,05	85	95	9,5	0,600	3,52
STANDARD	8/15/74	A-26	357FMU	1973	PONTIAC	POOR	NO	100	98	0,00	-0,20	85	93	5,4	0,490	5,31
STANDARD	8/15/74	A-27	239LCD	1974	CHEVROLET	GOOD	NO	0	90	0,00	-0,05	85	92	12,5	1,440	5,73
STANDARD	8/15/74	A-28	371GES	1972	DATSUN	GOOD	NO	0	88	0,00	-0,15	85	90	7,3	0,750	5,48
STANDARD	8/15/74	A-29	XDK720	1969	VOLKSWAGON	GOOD	NO	100	88	0,00	0,05	85	90	9,4	1,010	5,70
STANDARD	8/15/74	A-30	179KVA	1974	CHEVROLET	GOOD	NO	2	100	-0,50	-0,20	85	90	11,6	0,890	5,31
STANDARD	8/15/74	A-31	1V24	1974	AUDI	GOOD	NO	100	85	0,00	-0,05	85	91	9,3	1,050	5,42
STANDARD	8/15/74	A-32	037JWG	1974	PORSCHE	POOR	NO	100	87	0,00	-0,50	85	90	11,8	0,080	5,24
STANDARD	8/15/74	A-33	040AXD	1969	VOLKSWAGON	GOOD	NO	100	85	0,00	-0,05	85	89	5,4	0,680	5,59
STANDARD	8/15/74	A-34	SCE030	1966	FORD	GOOD	NO	45	95	0,00	-0,10	85	90	5,4	0,230	6,61
STANDARD	8/15/74	B- 1	172KDT	1972	CHEVROLET	GOOD	NO	0	80	0,00	-0,22	77	70	8,2	0,990	5,72
STANDARD	8/15/74	B- 2	122DXD	1968	FIAT	POOR	YES	100	0	0,00	-0,22	80	72	9,1	1,010	5,35
STANDARD	8/15/74	B- 3	96328H	1971	CHEVROLET	GOOD	NO	100	67	0,00	0,08	80	74	15,8	2,130	4,51

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LICENSE    VAPOR  DELTA  VEHICLE             SAT    BASE    ACT     AMT    HC %     HC
           LIQUID TEMP   DESIGNATION          HC     RET    RET      HC    RECV   EMISS
           RATIO                             CONC     HC     HC    LOST    BASE  GM/GAL
863EFK      0.70     -6 REGULAR              39.8    66.7   45.4    21.3    68.1   1.431
853JTZ      0.66      2 REGULAR              41.8    62.3   46.4    16.0    74.4   1.050
E803228     0.68     -2 REGULAR              46.2    74.0   52.4    21.6    70.8   1.421
693JAW      0.93     -9 REGULAR              43.9    44.1   38.3     5.8    86.8   0.686
145J2F      0.01      0 REGULAR              43.2    27.7    0.4    27.3     1.3   4.340
544CLI      0.72      2 BASELINE             43.2    31.4   25.2     6.2    80.4   0.832
106HBZ      0.02     -6 REGULAR              43.2    39.4    0.7    38.7     1.8   4.780
513JAY      0.79      2 BASELINE             45.4    82.0   72.8     9.2    88.8   0.500
368FRI      0.31      8 REGULAR              46.2    45.1   17.5    27.6    38.7   2.468
538FDQ      0.79     -2 FORCE FIT            44.7    25.4   20.9     4.5    82.3   0.832
1552IN      0.89     -3 REGULAR              44.7    81.9   74.9     7.0    91.5   0.409
XZP598      0.54      4 REGULAR              43.2    24.9   15.6     9.3    62.7   1.521
ZUY008      0.44     -7 REGULAR              44.7    35.3   15.0    20.2    42.7   2.932
254LBF      1.17     -1 BASELINE             45.4    53.0   78.4   -15.4   124.4  -1.146
STJ314      0.36    -84 BAD READING          52.7   102.0   16.0    85.9    15.7  11.309
B71060      0.76     -3 REGULAR              52.7    51.4   39.9    11.6    77.5   1.271
765AXC      0.62     -4 REGULAR              51.9   113.1   71.2    41.9    62.9   2.095
RLH603      0.71      6 REGULAR              51.0    25.0   21.4     3.6    85.4   0.674
095BGW      0.96      0 REGULAR              51.0    24.4   25.2    -0.8   103.1  -0.163
294FSZ      0.87      8 BASELINE             51.0    23.6   26.0    -2.4   110.2  -0.455
193HCJ      0.79      3 REGULAR              52.7    33.0   29.9     3.1    90.6   0.478
MNC554      0.35     -1 REGULAR              51.0    75.0   28.1    46.9    37.4   3.305
E551741     0.80      9 REGULAR              51.0    67.9   69.6    -1.7   102.4  -0.106
474FQV      0.60      9 REGULAR              52.7    75.2   57.6    17.6    76.7   1.051
1400783     0.54     12 REGULAR              55.4    42.1   31.0    11.1    73.6   1.170
357FMU      0.68     13 REGULAR              53.6    22.6   21.6     1.0    95.5   0.190
239LCD      0.86      5 REGULAR              52.7    61.1   62.4    -1.3   102.2  -0.107
371GES      0.77      3 BASELINE             51.0    35.9   31.4     4.4    87.7   0.605
XQK720      0.80      3 REGULAR              51.0    46.2   42.3     3.8    91.7   0.407
179KVA      0.57     15 BASELINE             51.0    44.1   37.3     6.8    84.7   0.582
1V24        0.84      0 REGULAR              51.9    49.1   44.8     4.3    91.2   0.464
037JWG      0.00      2 REGULAR              51.0    59.1    0.0    59.1     0.0   5.005
040AXD      0.94      0 REGULAR              50.2    27.6   28.0    -0.5   101.7  -0.087
SCE030      0.32     10 REGULAR              51.0    23.0    9.6    13.4    41.9   2.477
172KDT      0.90      3 REGULAR              36.6    28.9   29.8    -0.9   103.0  -0.107
122DXQ      0.83    -80 BAD READING          37.8    85.1   31.4    53.7    36.9   5.900
96328H      1.01    -13 REGULAR              39.1    77.5   68.5     9.0    88.4   0.571
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STATION	DATE	TEST NO	LICENSE	YEAR	MAKE	TYPE OF FIT	SPT BAK	EXP RDG	VEH TK TMP	VEH TK PRES	SYS PRES	GAS TMP	VAP TMP	AMT GAS	VOL VAP DISP	DISP RATE
STANDARD	8/15/74	B- 4	E15841	1962	FORD	GOOD	NO	100	69	0,00	0,10	79	74	10,7	1,440	5,84
STANDARD	8/15/74	B- 5	703DXP	1971	DODGE	GOOD	NO	0	79	0,00	-0,08	80	75	14,0	1,450	5,22
STANDARD	8/15/74	B- 6	934HCM	1973	CHEVROLET	GOOD	NO	0	69	0,58	0,18	82	76	17,2	2,450	5,40
STANDARD	8/15/74	B- 7	62155K	1972	FORD	GOOD	NO	100	72	0,00	-0,08	83	78	11,2	1,280	5,42
STANDARD	8/15/74	B- 8	326HCT	1973	DODGE	GOOD	NO	50	83	0,25	-0,08	82	79	15,2	1,740	5,01
STANDARD	8/15/74	B- 9	S581	1964	FORD	GOOD	NO	0	76	0,00	-0,22	83	80	5,4	0,630	5,23
STANDARD	8/15/74	B-10	021FXD	1972		GOOD	NO	0	98	-0,15	-0,24	82	80	11,1	0,790	5,41
STANDARD	8/15/74	B-11	145EEZ	1972	CHEVROLET	POOR	NO	100	78	0,00	-0,30	82	80	6,4	0,000	5,57
STANDARD	8/15/74	B-12	569EEY	1972		GOOD	NO	0	94	-0,15	-0,46	75	80	7,7	0,550	5,37
STANDARD	8/15/74	B-13	6015850	1969	VOLKSWAGON	GOOD	NO	100	80	0,00	-0,16	79	80	6,0	0,600	5,01
STANDARD	8/15/74	B-14	50254F	1970	FORD	POOR	NO	100	85	0,00	-2,00	80	78	16,0	0,070	8,42
STANDARD	8/15/74	B-15	YLZ244	1969	RAMBLER	GOOD	NO	100	91	0,00	-0,20	80	78	8,6	0,890	5,55
STANDARD	8/15/74	B-16	062EEZ	1972	MERCURY	GOOD	NO	0	84	0,40	-0,04	81	85	13,6	1,640	5,40
STANDARD	8/15/74	B-17	814GUV	1971	FORD	GOOD	NO	0	95	0,00	-0,60	80	85	18,6	1,460	5,42
STANDARD	8/15/74	B-18	969EFK	1972	CHEVROLET	GOOD	NO	0	90	0,65	0,02	80	85	9,1	1,050	6,20
STANDARD	8/15/74	B-19	69435P	1973	GMC	GOOD	NO	0	93	0,00	0,02	81	85	15,7	1,930	5,26
STANDARD	8/15/74	B-20	936EFZ	1972		GOOD	NO	0	94	0,07	-0,01	81	86	11,4	1,270	7,43
STANDARD	8/15/74	B-21	041170	1972	FORD	GOOD	NO	100	89	0,00	-0,10	80	85	7,4	0,750	5,77
STANDARD	8/15/74	B-22	166JVU	1967	BUICK	GOOD	NO	100	93	0,00	-0,18	80	85	11,8	1,200	5,45
STANDARD	8/15/74	B-23	T77570	1963	DODGE	GOOD	NO	0	91	0,00	0,04	80	85	19,9	2,270	5,15
STANDARD	8/15/74	B-24	CQB129	1964		GOOD	NO	100	90	0,05	-0,16	80	85	12,7	0,850	5,00
STANDARD	8/15/74	B-25	685FQM	1972	DODGE	POOR	NO	100	0	0,00	-0,16	80	85	12,7	0,000	6,35
STANDARD	8/15/74	B-26	619JVU	1974		GOOD	NO	10	0	0,00	0,00	80	84	6,1	0,720	5,15
STANDARD	8/15/74	B-27	257JBQ	1973		GOOD	NO	0	94	0,00	0,01	80	84	9,6	1,000	5,00
STANDARD	8/15/74	B-28	ZFV266	1969	VOLKSWAGON	GOOD	NO	0	89	0,00	-0,01	80	85	5,4	0,500	5,48
STANDARD	8/15/74	B-29	08346W	1973	DATSUN	GOOD	NO	100	89	0,00	-0,32	80	85	5,4	0,660	6,00
STANDARD	8/16/74	B- 1	617HKS	1973		GOOD	NO	0	60	0,00	-0,10	70	65	5,4	0,830	5,40
STANDARD	8/16/74	B- 2	YMN570	1963	CHEVROLET	GOOD	NO	0	58	0,00	-0,06	70	65	5,4	0,830	6,00
STANDARD	8/16/74	B- 3	389GET	1973	OLDSMOBILE	GOOD	NO	0	68	1,00	-0,10	75	70	13,7	1,750	6,13
STANDARD	8/16/74	B- 4	XQV720	1969	VOLKSWAGON	POOR	NO	100	60	0,00	-0,06	77	74	8,0	1,050	5,22
STANDARD	8/16/74	B- 5	933JBV	1974		GOOD	NO	30	64	2,20	-0,08	77	73	5,4	0,840	4,85
STANDARD	8/18/74	B- 6	E834102	1974	AM MOTORS	GOOD	NO	0	72	0,00	-0,06	77	75	12,0	1,300	5,54
STANDARD	8/16/74	B- 7	602JVT	1974	CHEVROLET	POOR	NO	100	63	0,00	-0,08	78	73	12,8	1,140	5,41
STANDARD	8/16/74	B- 8	572GES	1968	VOLKSWAGON	GOOD	NO	15	58	0,00	-0,06	78	75	5,4	0,870	5,68
STANDARD	8/16/74	B- 9	RWY685	1966	FORD	GOOD	NO	0	76	0,00	-0,08	78	76	5,4	0,770	5,89
STANDARD	8/16/74	B-10	297HIP	1968	CHEVROLET	GOOD	NO	100	58	0,00	-0,06	78	75	17,0	1,970	8,29
STANDARD	8/16/74	B-11	539FQQ	1971	CHEVROLET	GOOD	NO	100	63	0,30	-0,04	78	77	8,5	0,800	5,60

LICENSE	VAPOR LIQUID RATIO	DELTA TEMP	VEHICLE DESIGNATION	SAT HC CONC	BASE RET HC	ACT RET HC	AMT HC LOST	HC % RECV BASE	HC EMISS GM/GAL
E15841	1.01	-10	FORCE FIT	39.1	50.2	46.3	3.9	92.2	0.365
703DXP	0.77	-1	REGULAR	39.8	57.7	47.4	10.3	82.2	0.733
934HCM	1.07	-13	BASELINE	40.4	87.2	81.4	5.8	93.4	0.336
62155K	0.85	-11	REGULAR	41.8	57.0	44.0	13.0	77.1	1.163
326HCT	0.86	1	FORCE FIT	42.5	64.5	60.8	3.8	94.1	0.249
5581	0.87	-7	REGULAR	43.2	26.7	22.4	4.3	83.8	0.803
021FXO	0.53	15	FORCE FIT	43.2	34.8	28.1	6.8	80.5	0.612
145EEZ	0.09	-4	REGULAR	43.2	30.1	2.8	27.3	9.4	4.266
569EEY	0.53	19	BASELINE	43.2	22.4	19.5	2.8	87.3	0.367
6015850	0.75	1	REGULAR	43.2	25.9	21.3	4.6	82.2	0.767
50254F	0.03	5	FORCE FIT	41.8	62.0	2.4	59.6	3.9	3.722
YLZ244	0.77	11	REGULAR	41.8	29.4	30.6	-1.2	104.0	-0.138
062EEZ	0.90	3	BASELINE	46.9	61.5	63.3	-1.8	102.9	-0.132
814GUV	0.59	15	REGULAR	46.9	65.0	56.3	8.7	86.6	0.468
969EFK	0.86	10	BASELINE	46.9	35.7	40.5	-4.8	113.5	-0.529
69435P	0.92	12	REGULAR	46.9	58.9	74.5	-15.5	126.4	-0.990
936EFZ	0.83	13	BASELINE	47.7	42.5	49.8	-7.3	117.2	-0.642
041170	0.76	9	REGULAR	46.9	29.7	28.9	0.7	97.6	0.098
166JVU	0.76	13	FORCE FIT	46.9	43.3	46.3	-3.0	107.0	-0.256
T77570	0.85	11	REGULAR	46.9	76.4	87.6	-11.2	114.7	-0.563
CQB129	0.50	10	FORCE FIT	46.9	49.8	32.8	17.0	65.8	1.341
685FQM	0.00	-80	INST. FAIL.	46.9	147.4	0.0	147.4	0.0	11.604
619JVU	0.88	-80	INST. FAIL.	46.2	69.6	27.3	42.3	39.2	6.934
257JBQ	0.78	14	REGULAR	46.2	33.8	37.9	-4.1	112.2	-0.430
ZFV266	0.80	9	FORCE FIT	46.9	21.6	22.4	-0.7	103.4	-0.135
08346W	0.91	9	REGULAR	46.9	21.6	25.5	-3.8	117.6	-0.707
617HKS	1.15	-10	BASELINE	33.7	21.8	23.0	-1.2	105.3	-0.215
YMN570	1.15	-12	REGULAR	33.7	22.5	23.0	-0.5	102.2	-0.092
389GET	0.96	-7	BASELINE	36.6	57.4	52.6	4.8	91.7	0.347
XQV720	0.98	-17	REGULAR	39.1	41.5	33.7	7.8	81.3	0.969
933JBV	1.16	-13	FORCE FIT	38.5	26.0	26.6	-0.5	102.0	-0.094
E834102	0.86	-5	REGULAR	39.8	52.9	45.1	7.8	85.3	0.649
602JVT	0.67	-15	REGULAR	38.5	63.5	36.0	27.5	56.7	2.147
572GES	1.21	-20	REGULAR	39.8	29.7	28.4	1.2	95.9	0.227
RWY685	1.07	-2	BASELINE	40.4	23.0	25.6	-2.6	111.2	-0.477
297HIP	0.87	-20	REGULAR	39.8	93.4	64.4	29.0	69.0	1.705
539FQQ	0.77	-15	FORCE FIT	41.1	45.1	29.7	15.4	65.9	1.806

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 STATION    DATE    TEST LICENSE  YEAR   MAKE        TYPE SPT EXP VEH  VEH   SYS GAS VAP AMT   VOL     DISP
                     NO                               OF  HAK RDG  TK   TK   PRES TMP TMP GAS   VAP     RATE
                                                      FIT         TMP  PRES                     DISP

STANDARD  8/16/74 B-12 371JVR    1974 DODGE       GOOD NO  100  61  0,00 -0,05 78  76  5,4  0,880    7,36
STANDARD  8/16/74 B-13 634AAL    1969 OLDSMOBILE  GOOD NO  100  61  0,00 -0,04 78  76 12,4  1,640    8,75
STANDARD  8/16/74 B-14 170KCR    1974 FORD        GOOD NO  100  72  0,00 -0,04 78  77 17,9  2,050    5,32
STANDARD  8/16/74 B-15 YUB234    1969 AUS AMER    POOR NO  100  68  0,00 -0,06 79  75  5,4  0,150    6,61
STANDARD  8/16/74 B-16 230EFJ    1972 FORD        GOOD NO   65  62  0,00 -0,06 79  77  8,2  1,280    8,48
STANDARD  8/16/74 B-17 871KCD    1974 DODGE       GOOD NO   10  80  0,00 -0,04 80  77  9,2  0,970    6,99
STANDARD  8/16/74 B-18 37912R    1963 FORD        POOR NO  100  64  0,00 -0,02 80  78 17,0  2,550    4,51
STANDARD  8/16/74 B-19 933JRV    1974 CHEVROLET   GOOD NO  100  62  1,50 -0,05 80  77  6,1  0,730    9,89
STANDARD  8/16/74 B-20 STARR1    1973             GOOD NO  100  69  0,00 -0,04 80  78 11,6  1,370    8,59
STANDARD  8/16/74 B-21 P18774    1964 DODGE       POOR NO  100  61  0,00  0,43 79  78  9,1  1,300    8,40
STANDARD  8/16/74 B-22 698AAL    1963             GOOD NO  100  71  0,00  0,33 78  78 13,4  1,420    7,96
STANDARD  8/16/74 B-23 56546J    1956 GMC         POOR NO    0  68  0,00  0,21 78  79  5,4  1,060    5,40
STANDARD  8/16/74 B-24 684RVY    1971 CHEVROLET   GOOD NO  100  65  0,00  0,26 78  79  9,9  1,150    5,12
STANDARD  8/16/74 B-25 221CGL    1971 OPEL        POOR NO  100  68  0,00 -0,14 79  80  7,6  0,000    7,60
STANDARD  8/16/74 B-26 402JIC    1972 CHEVROLET   GOOD NO    0  72  0,00 -0,06 81  80 23,5  3,090    6,16
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LICENSE   VAPOR  DELTA  VEHICLE            SAT    BASE    ACT     AMT    HC %     HC
          LIQUID TEMP   DESIGNATION        HC     RET     RET     HC     RECV   EMISS
          RATIO                           CONC    HC      HC     LOST    BASE  GM/GAL
371JVB     1.22   -17 REGULAR             40.4    29.0    29.2   -0.3   101.0  -0.052
634AAL     0.99   -17 REGULAR             40.4    66.5    54.5   12.0    81.9   0.969
170KCR     0.86    -6 REGULAR             41.1    82.9    69.3   13.6    83.5   0.762
YUB234     0.21   -11 REGULAR             39.8    26.1     4.9   21.2    18.8   3.933
230EFJ     1.17   -17 REGULAR             41.1    44.7    43.2    1.5    96.7   0.179
871KCD     0.79     0 REGULAR             41.1    38.5    32.8    5.7    85.2   0.620
37912R     1.12   -16 REGULAR             41.8    93.0    87.6    5.4    94.2   0.316
933JBV     0.90   -18 FORCE FIT           41.1    33.7    24.7    9.0    73.2   1.483
STARR1     0.88   -11 REGULAR             41.8    59.0    47.1   12.0    79.7   1.032
P18774     1.07   -18 FORCE FIT           41.8    51.1    44.7    6.5    87.3   0.713
698AAL     0.79    -7 REGULAR             41.8    64.1    48.8   15.3    76.1   1.145
56546J     1.47   -10 FORCE FIT           42.5    27.5    37.0   -9.5   134.5  -1.760
684BVY     0.87   -13 REGULAR             42.5    52.7    40.2   12.6    76.1   1.272
221CGL     0.00   -11 FORCE FIT           43.2    40.0     0.0   40.0     0.0   5.260
402JIC     0.98    -9 REGULAR             43.2   119.9   109.7   10.2    91.5   0.434
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5.0 BULK TERMINAL TEST REPORT

5.1 Introduction

Source testing of hydrocarbon emissions resulting from bulk terminal loading operations was conducted by a team from Betz Enviornmental Engineers during December, 1974. These tests were intended to determine control efficiencies which can be expected to result from the use of commercially available hydrocarbon vapor recovery systems.

Two vapor recovery systems were tested. The first system was a compression-refrigeration-absorption system and the second was an open refrigeration system. Testing of the compression-refrigeration-absorption system was conducted in Philadelphia, Pennsylvania at a bulk terminal operated by Exxon during the week of December 9. The refrigeration system was tested the week of December 16 at a bulk terminal operated by Exxon in Baytown, Texas.

5.2 Conclusions

The following comments and conclusions are presented to summarize the results of the terminal testing program.

(1) The compression-refrigeration-absorption type unit should be able to achieve greater than 90% reduction of hydrocarbon emissions from loading operations for tank trucks that supply service stations equipped with Stage II controls. Greater than 80% reduction of these vapors is

achievable under today's conditions. Both recoveries assume no loss of vapors through leakage from tank truck openings.

(2) The refrigeration type unit should be able to achieve greater than 90% reduction of hydrocarbon emissions from loading operations under today's conditions. For tank trucks supplying service stations with vapor recovery controls, an efficiency of 95+% should be achievable using this type of unit. This also assumes no tank truck leakage.

(3) Leakage of hydrocarbon vapors from tank trucks is a significant source of emissions. Routine inspection and maintenance of vapor seals on tank truck openings should greatly reduce these emissions.

(4) The test method used provided sufficient data to permit material balance calculations around the recovery units. The test method appears to be valid for use on other types of vapor recovery systems.

(5) The hydrocarbon concentration of vapors emitted from a vapor processing unit is relatively constant and is fixed by vapor-liquid equilibria-relationships at the operating conditions of the processing unit.

(6) An increase in the hydrocarbon concentration of tank truck vapors should result in an increase in the vapor recovery efficiency of a processing unit.

5.3 System Description

5.3.1 Basis of Test Unit Selection

The two systems tested were selected after Radian had completed a review of vapor recovery systems available for terminal use. Factors considered in the selection of the test systems were: (1) the principle of operation, (2) the expressed demand for the system, (3) available information on operating reliability, (4) predicted theoretical efficiencies, and (5) the location of systems available for testing.

The systems tested were selected for the following reasons:

Refrigeration Unit

- low cost,
- very high predicted vapor recovery efficiency,
- large interest expressed by oil companies,
- continuous vapor processing,
- no compression of hydrocarbon vapors,
- no saturation of hydrocarbon vapors;

Compression-Refrigeration-Adsorption Unit

- predicted vapor recovery efficiency of 90%,
- manufacturer highly experienced in hydrocarbon vapor recovery,
- mode of operation different from refrigeration unit:

- .. batch vapor processing,
- .. saturation of vapors,
- .. compression of vapors.

5.3.2 Compression-Refrigeration-Absorption

5.3.2.1 Principle of Operation

Gasoline vapors, collected from tank truck loading operations are first sprayed with gasoline to insure that they are outside of the explosive range, then compressed and cooled. Water and heavy hydrocarbons which condense are collected in a separator. The vapors go to an absorber where the light uncondensed hydrocarbons are absorbed in fresh gasoline. Essentially hydrocarbon-free air collects in the top of the absorber and is released to the atmosphere through a control valve and flame arrester. The gasoline in the absorber is continuously recirculated, cooled, and replenished with fresh gasoline. The unit is designed for the absorber to operate at 50 psig and 0°F.

Premium gasoline from storage is used to cool the refrigerant condenser and as a source of fresh absorbent. The fresh absorbent stream is first used in the saturator and passes through an economizing heat exchanger as it enters the absorber. The rich absorbent also passes through the economizing heat exchanger before being pumped back to storage. Figure 5.3-1 is a schematic of a compression-refrigeration-absorption unit.

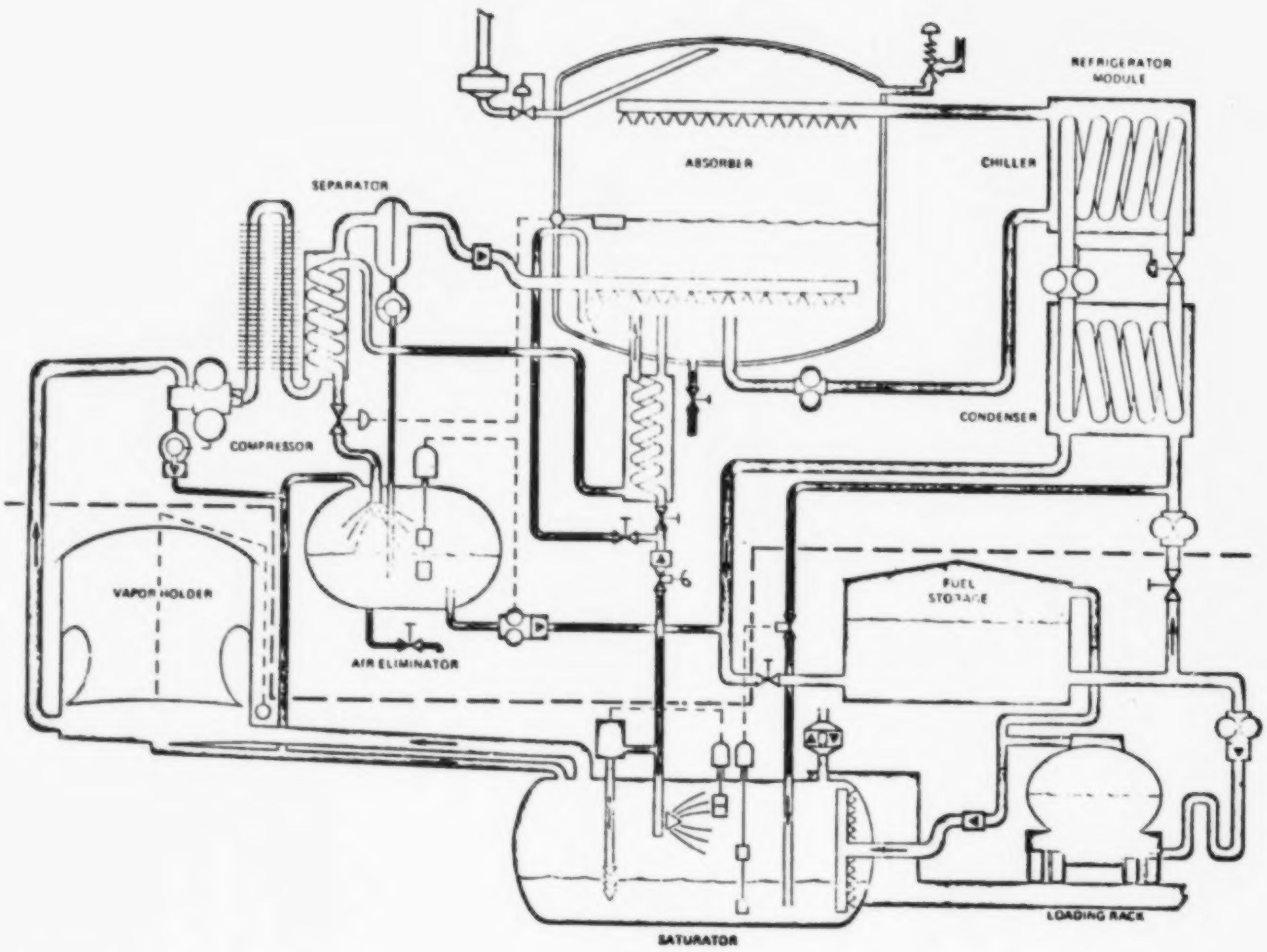
REFRIGERATOR MODULE
SEPARATOR
ABSORBER
CHILLER
COMPRESSOR
CONDENSER
6
VAPOR HOLDER
FUEL STORAGE
AIR ELIMINATOR
SATURATOR
LOADING RACK

FIGURE 5.3-1 - SCHEMATIC OF A COMPRESSION-REFRIGERATION-ABSORPTION VAPOR RECOVERY SYSTEM

5.3.2.2 Operations of the Test Unit

Vapors collected from the loading of tank trucks were saturated and then stored in a vapor storage tank which employed an expandable bladder for vapor containment. At a set level, the vapor recovery unit would come on line and process the contained vapors. It is estimated that about 2500 ft^3 of vapors were processed during each cycle.

Throughout the test period, the vapor recovery unit operated with no apparent problems. Absorber operating conditions varied only slightly, with pressures ranging from 48-52 psig and temperatures ranging from 0-4°F.

The unit tested received vapors from three loading racks for processing. Only two loading racks, however, were used during the tests due to sampling equipment limitations. The test was designed to provide data to permit material balance calculations by monitoring all vapors from the trucks passing to the processing unit and all vapors emitted from the processing unit. At the beginning of each day of sampling, before data were taken, the processing unit was manually tripped and all vapors in the vapor holder were processed. This procedure was repeated at the end of a sampling day to insure that all vapors monitored from the loading operations were also monitored after processing.

5.3.3 Refrigeration

5.3.3.1 Principle of Operation

Vapors displaced from tank truck loading operations are routed directly to a finned tube vapor condenser where moisture and hydrocarbons are condensed and separated from the vapors. Because vapors are treated on demand, no vapor holder is needed. Entrained moisture in the entering vapor-air moisture condenses and collects as frost on the cold plate fins. Condensed liquid hydrocarbon is collected at the bottom of the vapor condenser.

The vapor condenser is continuously maintained at a low temperature (about -90 to -100°F) by the circulation of low temperature brine coolant through the condenser tubes. The circulating coolant, methylene chloride, is circulated through an evaporator-interchanger to maintain its low temperature. A cascade refrigeration system is used to produce temperatures of about -110°F in the evaporator-interchanger.

At intervals, defrosting of the condenser fins is accomplished by circulation of warm coolant stored in a separate reservoir. The temperature of the warm defrost coolant is maintained by heat reclamation from the refrigeration equipment. Defrosting is completed in 10 to 30 minutes depending upon the amount of frost collected on the finned coil. Figure 5.3-2 depicts a schematic of a refrigeration unit.

5.3.3.2 Operations of the Test Unit

The terminal used for testing had only one gasoline loading rack. Vapors produced from tank truck loading operations were routed directly to the vapor condenser. There was no vapor holder; the unit processed all vapors "on the fly".

Operational problems were encountered with this system during the tests. It was discovered at one point on Monday, December 16, that a leak had developed in the high pressure portion of the refrigeration system. A low temperature could not be maintained in the evaporate-interchanger

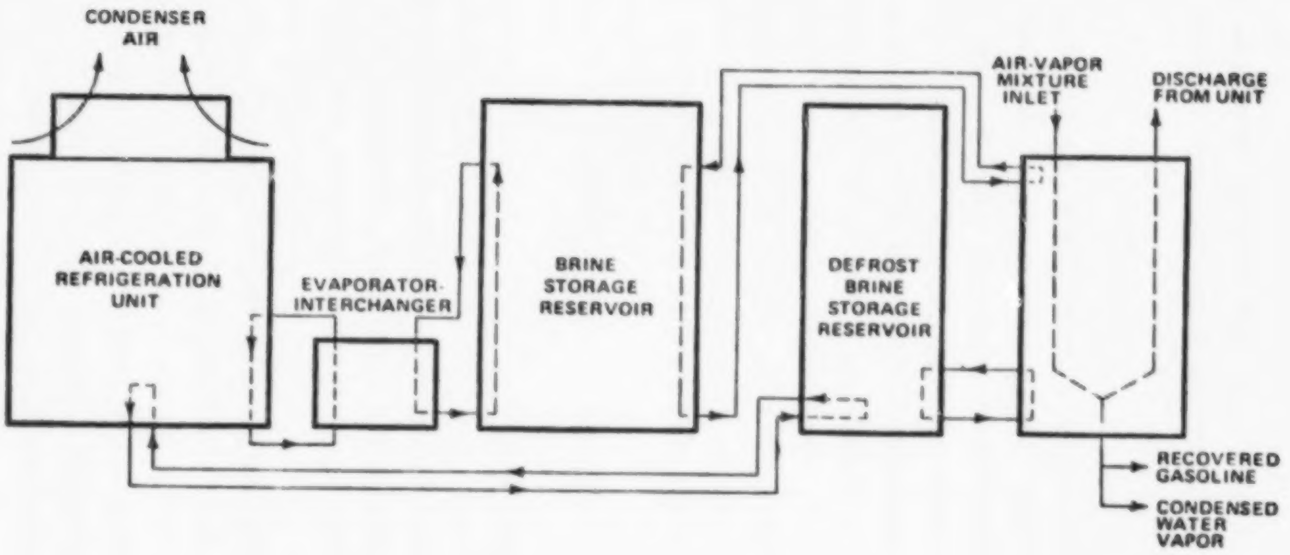
CONDENSER AIR
AIR-COOLED REFRIGERATION UNIT
EVAPORATOR-INTERCHANGER
BRINE STORAGE RESERVOIR
DEFROST BRINE STORAGE RESERVOIR
AIR-VAPOR MIXTURE INLET
DISCHARGE FROM UNIT
RECOVERED GASOLINE
CONDENSED WATER VAPOR

FIGURE 5.3-2 - SCHEMATIC OF AN OPEN REFRIGERATION VAPOR RECOVERY SYSTEM

because refrigerant (Freon 503) had leaked from the system. A service engineer was flown in from the manufacturers headquarters to repair the unit.

Because of this leak, the circulating coolant could not be maintained at its design temperature, and hence the vapor condenser operated above optimum temperature. The coolant storage reservoir is designed to contain enough cold brine to permit hydrocarbon recovery while minor repairs are made to the system. Testing was therefore conducted while the refrigeration portion of the unit was not in service. Condenser temperatures observed during these tests averaged about -50°F whereas the condenser temperature observed during testing after the leak was fixed averaged about -60°F.

5.4 Sampling Chronology

5.4.1 Philadelphia Tests

Two days were spent setting up and checking out equipment at the Philadelphia terminal. Testing was begun the third day, December 11, with no apparent problems.

Material balance checks on the sampling data indicated, however, that one of the hydrocarbon vapor flow meters was operating improperly. An equipment inspection the following morning showed that the problem was caused by liquid gasoline which had collected in the meter. The source of the gasoline was not determined, but due to the quantity involved, it was suspected of coming from the overfill of a truck.

On Thursday, December 12, testing was conducted with no problems. Flow meters were frequently inspected throughout the day for collected gasoline. Material balance checks of the data indicated all was well. Thursday night and Friday morning the test equipment was dismantled and loaded into a van for transport to Baytown.

5.4.2 Baytown Tests

Equipment setup and check-out took only one day. Testing was begun on Tuesday, December 19, even though the unit was not properly operating. As discussed in Section 5.3, the high pressure refrigerant system had a leak which affected the temperatures of the whole refrigeration unit. Condenser temperatures of -50°F were observed, and testing was initiated to determine how the system would operate under adverse conditions.

On December 18, the unit was still under repair and the condenser temperature had risen to -20°F. Testing was not conducted on that day.

Testing was resumed December 19, after the completion of repairs to the unit. The condenser temperatures averaged around -60°F throughout the day.

A minor problem occurred in measuring the temperature of the unit off-gas. Apparently the thermocouple originally used for this measurement did not extend far enough into the gas stream to obtain a true reading and the value being measured was influenced by the wall temperature of the pipe. A thermistor was finally used which extended well into the vapor stream and produced a constant and reproducible value. A value of 10°F was consequently used for this value in all calculations performed by Radian.

5.5 Results

Hydrocarbon vapor recovery efficiencies were calculated for each of the systems tested. Results for the compression-refrigeration-absorption system were based solely upon data collected on December 12. Data taken on December 11 were not used due to improper operation of one of the flow meters. Results were calculated for both days of tests on the refrigeration unit.

5.5.1 Compression-Refrigeration-Absorption Unit

Material balance calculations indicated that the hydrocarbon recovery efficiency of the collected vapors displaced from loading operations was 82%. A computer equilibrium model developed by Radian predicted a vapor recovery of 83% for the test conditions. The test data indicated that the hydrocarbon vapors approached equilibrium conditions in the vapor recovery system. They also showed the model to be a valuable tool for predicting recovery efficiencies.

After the implementation of Stage II controls at service stations, the hydrocarbon concentration of vapors displaced from loading operations will be higher than those measured during this test period. The hydrocarbon concentration of the displaced vapors from loading operations should at that time approach saturated values.

Several samples of the vapors were taken after they had passed through the saturator. These samples were then used to provide data for calculation of recovery efficiencies at conditions that would approximate those occuring after implementation of Stage II vapor recovery controls at service stations.

After the saturator, the hydrocarbon concentration had changed from an average value of 24% to one of about 53% (both percentages expressed as propane). The hydrocarbon recovery efficiency of the higher vapor concentration was calculated to be 92%. The computer predicted value was also 92%.

These tests illustrated the point that the degree of recovery efficiency achieved by a recovery system is proportional to the hydrocarbon concentration of the vapors displaced from loading operations since the concentration of vapors at the outlet of a vapor recovery unit is relatively constant and is fixed by equilibrium conditions which are determined by the operating temperature and pressure of the unit. Measured hydrocarbon recovery efficiencies can be expected to increase as service station vapor recovery controls begin to be implemented since this will tend to increase the hydrocarbon concentration of vapors displaced from the tank trucks. Tables 5.5-1 and 5.5-2 present summaries of data taken during testing of the compression-refrigeration absorption type unit.

The total amount of hydrocarbons collected from loading operations on December 12 was 93,561 grams (0.73 gm/gallon of fuel loaded). The amount of hydrocarbons emitted to the atmosphere from the recovery unit was 16,810 grams (0.13 gm/gallon of fuel loaded).

5.5.2 Refrigeration Unit

The average hydrocarbon recovery efficiency of this unit was found to be 85% on December 17, 1974. During these tests, a temperature indicator which monitored the vapors leaving the condenser indicated a condenser temperature of -50°F.

TABLE 5.5-1

PHILADELPHIA TRUCK DATA SUMMARY

Test Number	Trailer Number	Displaced Volume (ft³)	Maximum Pressure (in. H_2O)	Vapor Temp. (°F)	Dispensed Gasoline (gallons)	Dispensed Gasoline (ft³)	Volume Ratio $\left(\frac{\text{Vapor}}{\text{Gasoline}}\right)$	Vapor* Hydrocarbon Concentration (%)	Hydrocarbon to Processing Unit (gram)	Hydrocarbon to Processing Unit (gm/gal)
12/11/74										
8-3	4275	673	----	46	8,050	1,076	0.625	17.8	6,474	0.80
6-2	4267	0	----	39	7,422	992	0.000	19.0	-----	----
8-4	4277	280	----	45	8,050	1,076	.260	14.0	2,123	0.26
6-3	4278	161	----	44	7,700	1,029	.156	19.5	1,703	0.22
8-5	4263	543	----	45	7,000	935	.581	12.5	3,775	0.53
6-4	4274	670	----	45	8,045	1,076	.623	27.	9,797	1.22
8-6	4279	357	----	45	8,050	1,076	.332	8.9	1,720	0.22
8-7	4268	607	----	45	8,050	1,076	.564	9.3	3,057	0.38
8-8	4275	493	----	45	7,000	935	.527	8.0	2,135	0.30
6-5	4263	28	----	40	6,964	931	.030	29.5	452	0.06
8-9	4274	329	----	44	8,050	1,076	.306	6.7	1,196	0.15
6-6	4276	5	----	40	7,000	935	.005	23.	-----	----
8-10	4267	397	4.2	45	8,050	1,076	.369	5.5	1,182	0.15
8-11	4275	500	8.5	45	7,000	935	.535	28.	7,582	1.08
6-7	4268	15	16.5	40	8,038	1,075	.014	29.5	-----	----
8-12	4277	132	----	45	8,050	1,076	.123	28.5	2,036	0.25
6-8	4278	10	11.0	41	8,050	1,076	.009	31.5	-----	----
12/12/74										
6-2	4279	356	3.0	46	7,500	1,003	0.355	29.5	5,576	0.76
8-1	4270	363	3.2	40	7,900	1,056	.344	13.8	2,739	0.35
8-2	29612	355	3.5	42	7,800	1,043	.340	6.7	1,296	0.16
6-3	4273	663	7.2	46	5,750	769	.862	28.5	10,212	1.77
6-4	4272	947	4.5	49	7,350	983	.963	31.5	16,027	2.17
6-5	4268	58	3.8	48	6,700	896	.065	31.5	983	0.15
8-3	4275	552	7.8	45	5,750	769	.717	13.1	3,916	0.68
6-6	4278	167	4.4	50	5,631	753	.222	38.0	3,403	0.61
8-4	4263	515	3.3	48	6,615	884	.583	18.6	5,156	0.78
8-5	4276	190	2.8	50	8,050	1,076	.177	2.5	255	0.03
6-7	4270	256	4.1	52	8,050	1,076	.238	28.0	3,828	0.47
8-6	4273	786	8.9	54	8,050	1,076	.730	13.7	5,729	0.71
8-7	4275	832	8.0	50	8,050	1,076	.773	18.3	8,163	1.01
8-8	4279	240	5.0	58	8,050	1,076	.223	17.6	2,230	0.28
8-9	4268	530	5.4	56	8,050	1,076	.493	17.0	4,775	0.60
8-10	4270	297	3.4	55	5,905	789	.376	23.2	3,653	0.62
6-8	4277	661	3.8	55	8,050	1,076	.614	29.5	10,354	1.27
6-9	4263	308	3.0	54	5,323	711	.433	31.5	5,161	0.96

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* Hydrocarbon percentages expressed as propane.

TABLE 5.5-2
PHILADELPHIA VAPOR RECOVERY UNIT DATA SUMMARY

Daily Totals	Vapors from Unit	Gasoline Temperature (°F)	Hydrocarbon Concentration	Hydrocarbon from Processing Unit (grams)	Hydrocarbon from Processing Unit (gm/gal)	System Efficiency
12/11/74	5,555	12	4.7	15,156	0.12	--
12/12/74	6,689	15	4.3	16,592	0.13	82

Equilibrium predictions of hydrocarbon recovery efficiencies at -50°F for this unit indicated that a recovery efficiency of only about 60% could be attainable with the inlet composition experienced during this test. Discussions with representatives of the unit manufacturer indicated that the temperature inside the condenser was probably 20 to 30°F colder than the temperature indicated at the condenser outlet. Equilibrium predictions at this lower temperature agree quite well with the measured value. Figure 5.5-1 is a plot of predicted removal efficiencies versus condenser temperatures for the average vapor composition observed during testing.

As was the case with the compression-refrigeration-absorption unit, the hydrocarbon concentration in the vapors emitted from the vapor recovery unit, was for all practical purposes, constant and fixed by the temperature and pressure of the unit. An increase in the hydrocarbon concentration of vapors processed by the unit will result in an increase in the hydrocarbon recovery efficiency for a given set of operating conditions.

On December 19, the hydrocarbon recovery efficiency was found to be 83%. The temperature of the vapors leaving the condenser averaged about -60°F. Unit operations on December 19 were somewhat less stable than on December 17 operations, probably because the system was not completely lined out after startup.

Hydrocarbon mass emissions for the two days of testing are summarized below. Tables 5.5-3 and 5.5-4 present summaries of all data obtained during testing of the refrigeration type unit.

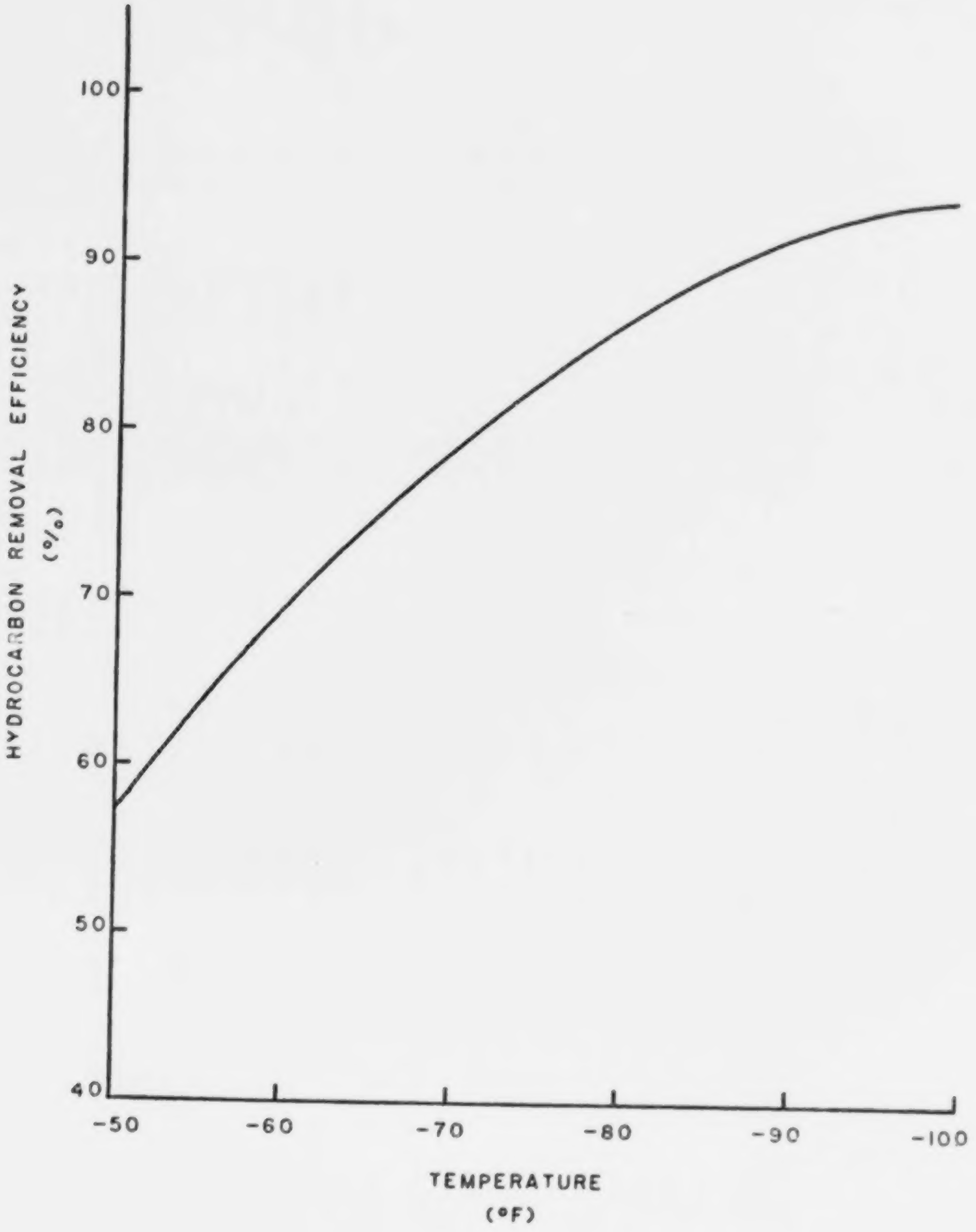

FIGURE 5.5-1 - HYDROCARBON REMOVAL EFFICIENCY VERSUS CONDENSER TEMPERATURE

TABLE 5.5-3

RAYTOWN TERMINAL TRUCK DATA SUMMARY

Test Number	Trailer Number	Displaced Volume (ft^3)	Maximum Pressure (in. H_2O)	Vapor Temp. (°F)	Dispensed Gasoline (gallons)	Dispensed Gasoline (ft^3)	Volume Ratio $\left(\frac{\text{Vapor}}{\text{Gasoline}}\right)$	Vapor* Hydrocarbon Concentration (%)	Hydrocarbon to Processing Unit (gram)	Hydrocarbon to Processing Unit (gm/gal)
12/17/74										
1	178	840	2.5	65	8,185	1,094	0.768	23.2	10,152	1.24
2	175	1,038	5.8	70	8,185	1,094	.949	14.6	7,820	0.95
3	176	699	5.0	70	8,185	1,094	.639	15.7	5,663	0.69
4	177	1,092	2.5	66	8,185	1,094	.998	20.5	11,639	1.43
5	4033	938	13.2	74	8,010	1,071	.876	11.2	5,380	0.67
6	7242	55	2.0	80	500	67	.821	10.8	300	0.60
7	149	163	2.0	74	3,330	445	.366	16.0	1,335	0.40
8	4033	920	12.5	73	8,010	1,071	.859	15.0	7,080	0.88
9	178	730	2.5	78	8,185	1,094	.667	23.3	8,646	1.06
10	176	492	2.5	74	8,185	1,094	.449	19.0	4,787	0.58
12/19/74										
1	4033	1,075	9.5	55	8,010	1,071	1.003	13.7	7,820	0.98
2	178	836	3.5	60	8,185	1,094	.764	23.0	10,111	1.23
3	175	1,192	3.0	60	8,185	1,094	1.089	21.5	13,478	1.64
4	150	982	4.8	70	7,025	939	1.045	24.0	12,161	1.73
5	7242	90	2.0	74	720	96	0.937	15.5	714	0.99
6	177	243	0.5	73	8,185	1,094	0.222	30.5	3,802	0.46
7	4033	1,105	19.0	65	8,010	1,071	1.032	11.6	6,677	0.83
8	222	258	~0.2	65	8,200	1,096	0.235	23.2	3,117	0.38
9	4033	1,116	16.0	62	8,010	1,071	1.042	11.0	6,431	0.80
10	231	137	0.2	70	8,200	1,096	0.125	18.9	1,335	0.16
11	7242	227	2.0	72	1,820	243	0.934	30.25	3,529	1.93
12	176	785	4.8	75	8,185	1,094	0.717	15.5	6,219	0.76
13	4033	1,038	---	73	8,010	1,071	0.969	11.8	6,285	0.78

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* Hydrocarbon percentages expressed as propane.

TABLE 5.5-4

BAYTOWN VAPOR RECOVERY UNIT DATA SUMMARY

Test Number	Vapors from Unit (ft^3)	Vapor[1] Temperature (°F)	Hydrocarbon[2] Concentration (%)	Total Hydrocarbon from Processing Unit (grams)	Total Hydrocarbon from Processing Unit (gm/gal)	System Efficiency (%)	Daily Average Efficiency (%)
12/17/74							
1	462	50	----	------	----		
2	744	25	3.61	1,565	0.19	80	85
3	366	27	3.77	804	.09	86	
4	727	25	3.70	1,568	.19	87	
5	504	25	3.64	1,069	.13	80	
6	50	28	1.76	51	.10	83	
7	308	35	3.82	685	.20	49	
8	377	30	3.00	659	.08	91	
9	503	40	3.00	879	.11	90	
10	343	36	3.37	674	.08	86	
12/19/74							
1	813	35	4.83	2,289	0.28	71	83
2	593	55	3.16	1,092	.13	89	
3	790	10	3.44	1,584	.19	88	
4	623	10	3.28	1,191	.17	91	
5	60	20	1.78	62	.09	91	
6	260	20	3.44	521	.06	86	
7	722	18	2.96	1,246	.16	81	
8	177	35	3.50	361	.04	88	
9	686	5	4.69	1,875	.23	71	
10	154	35	2.60	233	.03	83	
11	144	40	2.25	188	.10	95	
12	572	15	3.91	1,304	.16	80	
13	814	10	3.79	1,798	.22	71	

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1. A vapor temperature of 10°F was used for calculations.
2. Hydrocarbon percentages expressed as propane.

	Hydrocarbons Collected from Loading Operations		Hydrocarbons Emitted from Unit	
Date	(grams)	(g/gal loaded)	(grams)	(g/gal loaded)
12/17	52,650	0.87	7,954	0.13
12/19	81,679	0.90	13,744	0.15

5.5.3 Tank Truck Leakage

The unit operating efficiencies and mass emission rates reported in Sections 5.5.1 and 5.5.2 are based only on the vapors actually collected and measured. At both test locations significant amounts of hydrocarbon vapors were emitted to the atmosphere primarily through leaks in the tank truck manhole covers which are located on the tops of the tankers to permit access to each fuel storage compartment. After several months of use, the vapor seals around these openings become loose and subject to leaks. An explosimeter was used to check for leaks on each truck, however, in some cases the leaks were so severe that the escaping vapors could be felt by hand.

All of the trucks tested at the Philadelphia terminal, except one, were found to leak. The ratio of the measured displaced vapor volume to the volume of gasoline loaded varied from about 0.2 to 0.86 for the leaking trucks. The truck found not to leak had a displaced vapor to liquid volume ratio of 0.963. The overall or average measured displaced vapor to liquid volume ratio on December 12 was 0.47.

Hydrocarbon leaks were also detected by explosimeter readings on most of the trucks loaded at the Baytown terminal. The overall collection efficiency of vapors was higher at the Baytown terminal, however. The average measured displaced vapors to dispensed liquid volume ratio was 0.86 on December 17 and 0.75 on December 19. The average for the test period was 0.79.

It is significant to note that when a truck was found to have little or no leakage, its volume ratio of displaced vapor to gasoline loaded was near one. This is the ratio which would be expected to result from bottom loading operations.

If it is assumed that a leak free truck will produce an equal volume of displaced vapor as dispensed gasoline, the total system efficiencies would be much lower than the efficiencies of the process units reported earlier due to vapors leaking from the trucks. To calculate these efficiencies any truck that had a vapor to liquid ratio less than 1.0 had its vapors adjusted to make the ratio become 1.0. The hydrocarbon concentration of the vapors was assumed to remain as measured for each truck. Applying these criteria to the test data yielded the results presented in Table 5.5-5.

TABLE 5.5-5

SUMMARY OF TEST RESULTS CORRECTED TO INCLUDE TANK TRUCK LEAKAGE

Location and Date	Total Displaced Vapors[1] (ft^3)	Measured Vapors[2] (ft^3)	Hydrocarbons in Total Vapors[1]		Hydrocarbons in Measured Vapors[2]		Total Hydrocarbons Emitted to Atmosphere[3]		Total System Efficiency[4] (%)	Vapor Recovery Unit Efficiency[2] (%)
			(gm)	(gm/gal)	(gm)	(gm/gal)	(gm)	(gm/gal)		
Philadelphia 12/12/74	17,189	8,076	195,131	1.5	93,561	0.73	118,380	0.9	39	82
Baytown 12/17/74	8,125	6,967	70,782	1.2	52,650	0.87	26,086	0.4	63	85
Baytown 12/19/74	12,131	9,084	120,605	1.3	81,679	0.90	52,670	0.6	56	83

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1. Results corrected to reflect a V/L ratio of 1.
2. Results reflect measured values; leaks are neglected.
3. Emissions are sum total of losses from leaks and from vapor recovery units.
4. Based on results corrected to a V/L of 1.

APPENDIX B

REFERENCED SUPPORT INFORMATION

1.0 GASOLINE VAPOR CONTROL-REGULATIONS

In certain areas of the country, hydrocarbon emissions attributable to gasoline marketing facilities are at such levels that regulations pertaining to their control have become necessary. This section contains discussions on the quantities and significance of these emissions, procedures provided by the Clean Air Act of 1970 for establishing national air quality standards, standards of performance for new stationary sources, and the status of control strategies.

Although the focus of this report is the study of vapor control systems for hydrocarbon emissions in the gasoline marketing industry, ambient air quality standards are briefly discussed here. Ambient air standards, which apply to existing facilities are an important forerunner to standards of performance for new sources and are central to much of the logic behind them. With some exceptions, equipment and control technology are the same for both types of standards.

1.1 The Clean Air Act

The Clean Air Act of 1970[1] serves as the basis for all laws and regulations on Federal, State, and local levels pertaining to the prevention and control of air pollution. The Act provides for the establishment of ambient air quality standards and standards of performance for new stationary sources. Each type of standard and its impact on the gasoline marketing industry will be briefly discussed below.

1.2 Ambient Air Quality Standards

1.2.1 Establishing and Implementing the Standards for Existing Sources

Briefly, the procedure provided by the Clean Air Act for the establishment of national air quality standards and the subsequent plans for meeting those standards in existing sources is as follows:

(1) Substances are determined to be air pollutants and are listed as such by the Administrator of EPA.

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[1] Clean Air Act (42 U.S.C. 1857 et seq.) includes the Clean Air Act of 1963 (P. L. 88-206), and amendments made by the Motor Vehicle Air Pollution Control Act--P.L. 89-272 (October 20, 1965), the Clean Air Act Amendments of 1966--P.L. 89-675 (October 15, 1966), the Air Quality Act of 1967--P.L. 90-148 (November 2, 1967), and the Clean Air Amendments of 1970--P. L. 91-604 (December 31, 1970).

(2) Air quality criteria, information on control techniques, and proposed national primary[2] and secondary[3] ambient air quality standards are issued within 12 months from the time a substance is listed as an air pollutant.

(3) Within 9 months of the promulgation of national primary or secondary ambient air quality standards each state must submit an implementation plan for maintaining and enforcing that standard in each of its air quality control regions (AQCR). Reasonable notice and public hearings must precede the publication of such plans.

(4) The Administrator of EPA will approve or disapprove state plans or portions thereof within 4 months of their submission. Plans may be more stringent than required to meet national standards but they cannot be less stringent.

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[2] Primary standards reflect the level of control required to protect the public health with an adequate margin of safety. Specific Federal compliance dates are set for primary standards which must be met irregardless of cost (RO-102).

[3] Secondary standards reflect the level of control required to protect the public welfare; to enhance the quality of the environment as opposed to protecting the public health. These standards are to be met within "a reasonable length of time" with states and local agencies setting compliance dates.

1.2.2 Ambient Air Quality Standard for Photochemical Oxidants

Hydrocarbons, the major emissions from gasoline marketing operations, are the subject of national standards, primarily because of their function as precursors of photochemical oxidants rather than because of their direct effect on the atmosphere (NA-009). The national primary and secondary ambient air quality standard for photochemical oxidants, measured and corrected for NO_x and SO_2 interferences, is 160 micrograms/cu. meter, 0.08 ppm,[4] maximum 1 hour concentration not to be exceeded more than once per year (40 CFR 50.9)

The standard for hydrocarbons measured and corrected for methane, which is used as a guide in preparing implementation plans to achieve the oxidant standard, is 160 micrograms/cu. meter, 0.24 ppm,[5] maximum 3-hour concentration (6-9 a.m.), not to be exceeded more than once per year (40 CFR 50.10). The correction for methane, which involves the subtraction of the methane concentration from the total HC concentration, is made because methane, considered to be a photochemically non-reactive hydrocarbon, is naturally present in the ambient atmosphere at a relatively high level. The non-urban background level for methane has been measured as 1.0-1.5 ppm (NA-009). This background level is primarily attributed to biological sources and considered uncontrollable.

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[4] Conversion between ppm and micrograms/cu. meter: ppm $O_3 = \frac{\text{micrograms } O_3}{m^3} \times 5.10 \times 10^{-4}$ (40 CFR 50, Appendix D).

[5] Conversion between ppm and micrograms/cu. meter: ppm carbon (as CH_4) = [mg. carbon (as CH_4)/m.^{3}] x 1.53 x 10^{-3} (40 CFR 50, Appendix E).

1.2.3 State Implementation Plans and Transportation Control Plans to Meet Ambient Air Standards

The Federal role, as provided for by the Clean Air Act of 1970, is primarily one of guidance and assistance to the states. The states are responsible for writing a plan "which provides for implementation, maintenance, and enforcement of primary and secondary standards in each air quality control region (or portion thereof) within their state". (Clean Air Act of 1970, Sec. 110(a) (1).)

In order to assist the states in channeling time and resources toward the control of the most complex air pollution problems first, EPA, in consultation with the States, has assigned a priority classification for SO_x, particulate matter, NO_x, CO, and photochemical oxidants (hydrocarbons) to each AQCR. A Priority I classification for a pollutant indicates that emissions are above the national standards for that pollutant. A Priority III rating indicates the emissions are below the level specified by the standards. Control strategies must specify a means of attaining and maintaining ambient air quality standards for all Priority I classifications. Provisions must also be made for maintaining emissions below secondary air quality levels in Priority III areas.

Priority ratings as described in 40 CFR 51.3 are based on measured ambient air quality where known or on estimated air quality. When no data is available, a Priority I classification is assigned to urban areas of 200,000 or more (latest census figures). Following a three month data collection period this classification may be changed to Priority III if the data indicate such reclassification is justified.

For photochemical oxidants (hydrocarbons), a Priority I classification is assigned to all AQCR with a photochemical oxidant level equal to or above 195 micrograms/cu. meter, 0.10 ppm, 1 hour maximum. Below this level, a Priority III classification is assigned.

1.2.4 Implementation Plans

In formulating control strategies, the states could apply a straight percentage rollback from baseline emissions in each AQCR to determine the percentage of control required to meet national ambient air quality standards. Baseline inventories include the projected effect of the Federal Motor Vehicle Control Program (FMVCP) and the projected effect of any existing state regulations.

The Clean Air Act of 1970 called for control strategies to include emission limitations and "such other measures as may be necessary to insure attainment and maintenance of primary or secondary standards, including, but not limited to, land use and transportation controls" (Section 110([illegible])). EPA recognized at the time, however, that the states had no experience with transportation control measures.[6] Accordingly, the implementation plans submitted in 1972 were oriented toward stationary source emission limitation controls.

Stationary source controls for photochemical oxidants (hydrocarbons) frequently involved the extension of existing controls or the writing of new requirements for the bulk storage and loading of organic chemicals such as gasoline. Table 1.2-1

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[6] Transportation control measures are defined as any measures which are directed toward reducing emissions of air pollutants from transportation sources.

TABLE 1.2-1

STATE VAPOR RECOVERY REGULATIONS

State	Effective Area	Requirements		
		Bulk Storage	Loading Rack	Smaller Storage
Alabama	Mobile County	Tanks of more than 60,000-gal. capacity require basic vapor-recovery gear.	Racks loading more than 50,000 gal. daily into truck tanks of 200-gal. capacity must have vapor collection and disposal system or equivalent and a loading system that results in a 95% submerged fill either with submerged fill pipe or loading from the bottom.	New storage tanks of more than 1,000-gal. capacity must have permanent submerged fill or basic vapor-recovery equipment. Existing storage shall use either portable or permanent submerged fills.
Arizona	State	Tanks of 65,000-gal. or more capacity require basic vapor-reocvery gear.	All rack loading must use submerged fill pipes	None at present, but regulations covering bulk storage plants and station tanks under consideration along with regulations on refueling cars.
California	Orange County	Basic vapor-recovery equipment required at all product-handling stages (terminal storage, bulk plant storage and station storage where tank capacity is greater than 250 gal.), and all loading racks regardless of throughput. Station storage must have submerged fill pipes. Systems must recover 90% of vapors generated.		
California	L.A. County	Basic vapor-recovery gear mandatory at all storage points where tank capacity is at least 40,000 gal. (station storage must have submerged fill pipes), and where loading racks handle at least 20,000 gal. a day. County planning to require vapor-recovery gear for storage.		
California	San Francisco Bay Area APCD	Where storage is greater than 42,000 gal. capacity per tank, vapor pressure is greater than 1.5 psia, and head-space reactivity is more than 5%, tanks must be controlled by floating-roof cover or approved equivalent. Storage under 42,000 gal. capacity each must have submerged fill.	Where throughput exceeds 25,000 gal. daily, vapor-removal equipment that is 85% efficient is required. For lower daily throughput, submerged fill is a must.	New stations (also includes existing stations where station storage has been increased): Storage must have 90% effective vapor-recovery equipment. Dispensers must have 90% effective equipment as soon as available but not later than Jan. 1, 1974. Existing stations: Storage and dispensers must have 90% effective vapor-recovery systems by July 1, 1974. Storage must also have submerged fill.
Colorado	State	New tanks of more than 40,000-gal. capacity require basic vapor-recovery gear.	None	None

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements		
		Bulk Storage	Loading Rack	Smaller Storage
Connecticut	State	Tanks of more than 40,000-gal. capacity require basic vapor-recovery equipment.	Racks loading at least 10,000 gal. daily into tank trucks, trailers or rail tankcars of more than 200 gal. capacity require basic vapor-recovery equipment.	Tanks of more than 250-gal. capacity (would include station storage, underground bulk-plant and above-ground bulk storage) must have (1) conservation vent valve (pressure-vacuum vent on end of tank vent line) and a permanent submerged fill pipe, or must be a pressure tank or fitted with a vapor-recovery system. No conservation vent valve required on floating roofers. Exempt: Tanks under 1,000-gal. capacity installed prior to effective date of rules or any underground tank installed prior to effective date where the fill line between fill connection and tank is offset.
District of Columbia	District	Tanks of more than 40,000-gal. capacity must have basic vapor-recovery equipment.	All racks must have basic vapor-recovery gear.	Tanks of more than 250-gal. capacity must have submerged fill pipe (station and underground bulkplant storage) or basic vapor-recovery equipment.
Florida	State	No specific regulations, but those who store, pump or handle, load or unload gasoline or organic solvents must use "known and existing vapor-emission control devices or systems deemed necessary and ordered by the Dept. of Pollution Control." They must use reasonable care to avoid discharging, leaking, spilling, seeping, pouring or dumping such compounds. Terminal and bulk-plant loading and unloading operations and station operations must also follow specific actions during various phases of an air-pollution alert.		
Idaho	State	No specific requirements, but at new facilities the best available methods to control emissions must be used.		
Illinois	State	Tanks of more than 40,000-gal. capacity need basic vapor-recovery gear; vapor gathering system must be capable of collecting 85% or more of uncontrolled vapors that would otherwise be emitted.	Racks with daily throughput of more than 40,000 gal. must use loading pipes equipped with air-pollution-control equipment capable of reducing by 85% or more the uncontrolled vapors that would otherwise be emitted.	Tanks of more than 250-gal. capacity require permanent submerged fill pipes or equivalent unless it is a pressure vessel or is equipped with basic vapor-recovery gear.
Indiana	Priority I AQCR and New Sources throughout State	Tanks of more than 40,000-gal. capacity must have basic vapor-recovery systems.	Racks loading 40,000 gal. daily or more must have basic vapor-recovery equipment when loading into any tank, tankcar, truck, trailer, or barge. Discussion going on whether requirement applies to lake tankers.	Tanks of more than 250-gal. capacity must have submerged fill pipe during loading or basic vapor-recovery gear.

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements		
		Bulk Storage	Loading Rack	Smaller Storage
Kansas	State	Tanks of more than 40,000-gal. capacity installed after Jan. 1, 1972 require basic vapor-recovery gear.	None	None
Kentucky	For Existing Facilities in Jefferson County (Louisville area) and in Boone, Kenton, Campbell, Gallatin, Carroll, Owen, Grant and Pendleton Counties in area adjacent to Cincinnati, Ohio, and to New Facilities everywhere.	Tanks of more than 40,000-gal. capacity require basic vapor-recovery equipment.	Racks loading more than 20,000 gal. daily require basic vapor-recovery system. If disposal part of vapor-collection and disposal system is a vapor-liquid-absorber unit, it must have 90% minimum efficiency.	Tanks of 500-gal. capacity or greater require submerged fill pipe or basic vapor-recovery gear.
Louisiana	State	Tanks of more than 50,000 gal, capacity require basic vapor-recovery gear.	Racks loading at least 40,000 gal. daily (any 30-day average) into trucks, trailers or servicing tanks of at least 200-gal. capacity must have vapor-collection and disposal equipment or equivalent. Provision must be made to prevent spills in attaching and disconnecting filling lines or arms.	Stationary storage of more than 250-gal. capacity (includes bulk-plant storage) must have submerged fillpipe, vapor-recovery system, or approved equivalent.
Maryland	Baltimore Metro Area. Montgomery Co., Prince Georges Co.	Basic vapor-recovery gear required on existing tanks greater than 65,000-gal. capacity and on new tanks of more than 40,000-gal. capacity.	New racks loading over 20,000 gal. a day and existing tanks loading more than 40,000 gal. daily require basic equipment.	After Jan. 1, 1974, 3-in. vapor-balance lines between tank and truck required in transfering product to or from any new tank of more than 5,000 gal. (includes station storage and bulk-plant storage). Tests now going on to see if 2-in. balance line suffices.
Massachusetts	Air Pollution Control Districts of Berkshire; Central Massachusetts; Pioneer Valley; Metropolitan Boston; Southern Massachusetts.	Tanks of more than 40,000-gal. capacity require basic vapor-recovery equipment. Where vapor pressure exceeds 11.0 psia, it can be any part of basic vapor-recovery equipment except a floating roof.	Racks loading over 20,000 gal. per day must have vapor-recovery systems, with a standard operating procedure approved by governing agency. Loading connections on vapor lines must be vapor-tight and close automatically when disconnected. Above equipment not required in refueling motor-vehicle fuel tanks.	Stationary storage of more than 5,000 gal. but less than 40,000 gal. (covers station and bulkplant storage filled from tank truck, trailer, or rail tankcar) must have vapor-balance line or equally effective discharge control system. Components of vapor-balance line consist of vapor-space connection on a tank and a compatible vapor-return line to the tank truck, trailer, or rail tankcar.

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements		
		Bulk Storage	Loading Rack	Smaller Storage
Minnesota	State	New storage of more than 65,000 gal. capacity must have basic recovery gear.	None	New tanks of more than 250-gal. capacity must be equipped with submerged fill pipe or have vapor-recovery equipment.
Mississippi	State	No specific rules apply to vapor-emission controls or vapor-recovery gear but state Air & Water Pollution Control Commission requires that those with storage of more than 25,000 gal. must register for a permit to operate facilities. Registration is free and purpose is to have some idea of number of sources handling product.		
Missouri	St. Louis, St. Louis County, and St. Charles, Franklin and Jefferson Counties	New storage of more than 40,000-gal. capacity requires basic vapor-recovery gear.	None	Tanks of 250-gal. capacity or more require permanent submerged fill pipe or basic vapor-recovery gear.
Montana	State	Tanks of more than 65,000 gal. required to have basic vapor-recovery equipment.	None	Tanks of 250-gal. capacity or greater must have submerged fill pipe or basic vapor-recovery equipment.
Nevada	State (except Clark Co.)	Tanks of more than 40,000-gal. capacity require basic vapor-recovery gear.	Must use submerged fill pipe.	As approved by state air pollution-control officer.
Nevada	Clark Co. (Las Vegas)	Tanks of more than 40,000-gal. capacity require basic vapor-recovery gear. Annual registration fee for each tank is $50. Wherever a facility is registered, control officer has right to install and maintain sampling and testing equipment to measure emission of air contaminants. Operators of such facilities must maintain required records of the nature and amount of emissions or other information required by the control officer and they must be submitted as part of any registration-renewal request.	None	Filling tanks of 250-gal. capacity or more requires submerged fill pipes (opening of pipe must be submerged when liquid level is 6 in. from bottom); hose connection to the tank fill pipe shall be a tight leak-proof connection. Submerged fill not required on any tank installed before Mar. 25, 1968 where the fill line between connection and tank is offset or on any tank of 2,000-gal. or less capacity installed before that date.
New York	New York City Westchester Co, Rockland Co, Nassau Co, Suffolk Co,	Tanks of more than 65,000-gal. capacity require basic vapor-recovery equipment, with floating roof usage permitted where vapor pressure is under 11.0 psia.	Racks loading an average of 40,000 gal. daily over a three-month period into mobile storage (tank trucks, trailers or rail tankcars of any size) must have basic vapor-recovery equipment or submerged fill pipes where less than 40,000 gal. daily is loaded, or other equally efficient ways of controlling air pollution meeting agency approval.	New station and new farm storage and existing bulk storage greater than 275-gal. capacity must have either a permanent submerged fill pipe or basic vapor-recovery equipment. Existing underground storage at stations and farm storage is not included.

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements		
		Bulk Storage	Loading Rack	Smaller Storage
N. Carolina	State	Tanks of more than 50,000-gal. capacity require basic vapor-recovery equipment. Where vapor collection system is used, it must be 90% efficient in reduction of vapor emissions.	Racks handling more than 20,000 gal. daily must load via submerged fill pipes or other acceptable means.	None
N. Dakota	State	New storage greater than 65,000 gal. capacity requires basic recovery gear.	None	None
Ohio	Priority I AQCR; and New Facilities throughout State.	Tanks of more than 65,000 gal. capacity must have (1) floating pontoon or double-deck type cover where vapor pressure is under 12.5 psia, (2) vapor recovery system that reduces emissions by at least 90% by weight, or (3) other approved means.	Racks loading more than 40,000 gal. daily must have basic vapor-recovery equipment or (1) absorber of condensation system that processes and recovers at least 95% by weight of all vapors and gases, (2) vapor-handling system which directs all vapors to a fuel gas system, or (3) other approved means.	Tanks of more than 500 gal. capacity must be filled by submerged fill pipe, be bottom-loaded or have floating pontoon or double-deck type cover.
Oklahoma	State	New tanks of more than 40,000-gal. capacity require basic equipment. If it's a vapor-recovery system, vapor gathering part must collect 85% of uncontrolled vapors.	Racks handling more than 40,000 gal. daily must have basic equipment. Vapor-disposal system can be (1) vapor-liquid absorber with 90% minimum recovery efficiency, or (2) variable vapor-space tank (vapor share, vapor dome or vapor miser) compressor, and fuel-gas system capable of handling vapors and gases displaced from tanks, trucks and trailers loaded. Racks handling 40,000 gal. daily or less must have equipment that can reduce by 70% or more the amount of uncontrolled vapors emitted under splash-loading conditions.	New tanks of 250-gal. capacity or more must have submerged fill pipe (applies to station and underground bulk-plant storage) or basic vapor-recovery system as outlined for bulk storage.
Oregon	Columbia-Willamette APCD, Mid-Willamette APCD	Tanks of more than 40,000-gal. capacity require basic vapor-recovery gear.	Racks handling 20,000 gal. daily or more must have basic vapor-recovery equipment.	Tanks of more than 500-gal. capacity must have submerged fill pipe (required on all tanks installed since Jan. 1, 1970 in Columbia-Willamette APCD) or basic vapor-recovery gear.

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements Bulk Storage	Loading Racks	Smaller Storage
Oregon	Lane Co. Regional APCD	New tanks of 1,500 gal. or more require submerged fill or adequate vapor-control devices. All existing installations in metropolitan area of APCD must comply by Jan. 1, 1975.		
Pennsylvania	Region I - Southeast Pennsylvania Air Basin; Region V - Allegheny County, Monongahela Valley, Beaver Valley (Beaver County) Air Basins; Region VI - Beaver Valley Air Basin in Lawrence County.	Tanks "rated at more than 40,000 gal." require basic vapor-recovery equipment.	Racks loading more than 20,000 gal. daily into any vehicular tank "rated" at more than 200 gal. must have basic vapor-recovery equipment.	None
Tennessee	State	At all new product-transfer points, present state regulations call for "use of best available current technology" to control emissions from volatile organic compounds. Of more than 90 counties in the state, four counties have air-pollution control programs that do not as yet cover volatile organic compounds. When and if they do, restrictions could be more severe than those at the state level.		
Texas	Bexar Co., Dallas Co., Travis Co., El Paso Co., Galveston Co., Harris Co., Nueces Co.,	Tanks of more than 50,000-gal. capacity require basic vapor-recovery gear. Proposal in the works to lower this to tanks of more than 25,000 gal. effective May 31, 1975.	Racks handling more than 20,000 gal. daily require basic vapor-recovery gear.	Tanks of more than 1,000-gal. capacity must have submerged fill pipe or other basic vapor-recovery gear.
Virginia	Fairfax, Arlington, Loudoun, and Prince William Cos.	Tanks of more than 65,000 gal. capacity must have basic equipment.	Racks loading 50,000 gal. a day or more must have basic equipment.	Tanks of more than 250-gal. capacity must have submerged fill pipes (applies to station and underground bulk-plant storage) or basic vapor-recovery equipment.
Wisconsin	S.W. Wisconsin Interstate Air Quality Control District	All involved in product, storage, handling, and use must take "reasonable precautions" to prevent hydrocarbon emission or escape.		
		New or modified (increased) storage over 40,000-gal. capacity must have basic vapor-recovery gear.	Racks with more than 40,000 gal. daily throughput must use vapor-collection and disposal system, vapor-collection adaptors, vapor-tight seal or underfill method (bottom loading) with top hatches partly closed or a means of creating a slight back pressure. Racks with 40,000-gal. daily throughput or less must use submerged fill of at least 95% or underfill method.	Permanent submerged fills must be used on tanks of more than 1,000-gal. capacity (station or bulk-plant storage) if tank doesn't have other basic vapor-recovery equipment. Also required: Systems to prevent spillage or leakage in filling tank, trucks, or trailers; "caution" used in filling automotive tanks to prevent spillage.

TABLE 1.2-1 (cont.)

State	Effective Area	Requirements		
		Bulk Storage	Loading Racks	Smaller Storage
Wyoming	State	Tanks of more than 65,000-gal. capacity require basic vapor-recovery gear. All waste-disposal combustion systems for organic compounds from a vapor blowdown or emergency relief system must be burned by smokeless flares or equally effective control device.	None	None

Source: Reprint National Petroleum News, 1973 (VA-084).

gives the National Petroleum News 1973 summary of state vapor recovery regulations. The list includes twenty-three states which had vapor recovery requirements in 1973 for one or more of the following points in the gasoline marketing industry: bulk storage, loading racks, and smaller storage (including service station storage). These regulations appear to have been patterned after the examples of emission limitations attainable with reasonable available technology published in 40 CFR Pt. 51, App. B as a guide for the preparation of state implementation plans.

Table 1.2-1 specifies the vapor recovery requirements, the affected areas in each state, and whether the requirements listed apply to existing and/or new facilities. As Table 1.2-1 indicates, all of the 23 states listed have bulk storage requirements: 22 states have loading rack requirements with eighteen specifying vapor recovery gear and four specifying submerged fill. Sixteen states have requirements for smaller storage facilities with five specifying vapor recovery gear and eleven specifying submerged fill or vapor recovery gear.

1.2.5 Transportation Control Plans

Because hydrocarbon emissions are primarily attributed to motor vehicles, the stationary source emission limitations included in the implementation plans were, in some cases, not sufficient to attain ambient air quality standards in AQCR's with heavy vehicle use. In these cases, the states were required to submit transportation control plans by 15 February 1973, as a supplement to their 1972 implementation plans. Table 1.2-2 specifies which AQCR's were required to submit such plans to attain the national standard for photochemical oxidants (hydrocarbons).

Both stationary and mobile source controls can fall into the category of transportation control measures. In general, stationary source controls included in transportation control plans involve controls, or the extension of controls, for the various phases of the gasoline marketing industry including storage, truck loading at terminals, truck unloading at service stations, and vehicle refueling. In some cases where such requirements were already in existence, the effective area of these controls was extended. Mobile source measures include reduction of vehicle miles traveled, inspection and maintenance programs, retrofit emission controls for in-use vehicles, and gasoline supply limitations.

TABLE 1.2-2

AQCR's REQUIRED TO SUBMIT TRANSPORTATION CONTROL PLANS TO MAINTAIN THE NATIONAL STANDARD FOR PHOTOCHEMICAL OXIDANTS (HYDROCARBONS)

Arizona	Phoenix-Tuscon Intrastate
California	San Francisco Bay Area Intrastate Metro L.A. Intrastate Sacramento Valley Intrastate San Joaquin Valley Intrastate San Diego Intrastate
Colorado	Metro Denver Intrastate
District of Columbia	National Capital Interstate
Indiana	Metro Indianapolis Intrastate*
Maryland	National Capital Interstate
Massachusetts	Metro Boston Intrastate
New Jersey	N.J., N.Y., Connecticut Interstate
New York	N.J., N.Y., Connecticut Interstate
Ohio	Metro Dayton Intrastate
Oregon	Portland Interstate
Texas	Austin-Waco Corpus Christi-Victoria Metro Houston-Galveston Metro Dallas-Fort Worth Metro San Antonio El Paso, Texas, Las Cruces, N.M., Alamorgordo
Virginia	National Capital Intrastate
Washington	Puget Sound Intrastate

Source: Federal Register 31 May 1972, pp. 10847-10906.

*Transportation control plan not specifically required.

The plans for most affected AQCR's involve some combition of the above controls depending on the degree of the pollution problem, the pollutant controlled, availability of control measures, existing local activities and conditions and the expected impact of specific new measures. Considering all factors, control strategies have generally followed these priorities: (1) stationary source control; (2) some VMT (vehicle miles traveled) reduction measures and/or limited inspection and maintenance; (3) additional VMT reduction measures and/or vehicle retrofits; (4) catalytic converter retrofits; (5) gasoline supply limitations in 1977 (EN-126).

According to an EPA summary dated 1 May 1974, transportation control plans and/or state or county regulations for ten states specify vapor recovery requirements for gasoline marketing operations and terminal loading. Table 1.2-3 lists the states and the 17 AQCR's involved. Vapor recovery control points include truck loading at terminals, service station unloading, and auto refueling. Two stages of controls have been identified for the purposes of implementing vapor recovery regulations at service stations. Controls placed on the filling of service station tanks are referred to as Stage I controls; while controls placed on the filling of vehicle tanks (vehicle refueling) are considered Stage II controls.

1.2.6 Compliance Schedules

The Clean Air Act of 1970 states that compliance dates for primary ambient air quality standards are three (3) years from the date of issuance, or 1975. A two-year extension is allowed in cases where the "necessary technology or other alternatives are not available or will not be available soon enough to permit compliance within such three-year period and the State has considered and applied as a part of its plan

TABLE 1.2-3 (Cont.)

VAPOR RECOVERY REGULATIONS FOR SERVICE STATIONS

STATE	TRANSPORTATION CONTROL PLAN *	STATE OR COUNTY REGS	TRUCK LOADING AT TERMINAL**	TRUCK UNLOADING AT SERVICE STATION	COMPLIANCE DATES[a] INITIAL	COMPLIANCE DATES[a] FINAL	AUTO REFUELING	COMPLIANCE DATES[a] INITIAL	COMPLIANCE DATES[a] FINAL
Indiana ***	Co. of Marion, Indianapolis		90% Control	90% vapor recovery	3/1/74	3/1/76	80% Control	3/1/74	7/1/76
Maryland		State reg., for Baltimore and Washington areas.	Control required	Vapor return line required on certain sources		1/1/74			
	Natl. Capital Interstate AQCR (Md. portion)		90% Control	90% Control	6/1/74	3/1/76	90% Control	6/1/74	5/31/77
	Metropolitan Baltimore AQCR		90% Control	90% Control	6/1/74	3/1/76	90% Control	6/1/74	5/31/77
Massachusetts		State reg., for Boston area	Control required	Vapor return line on new sources		7/31/75			
	Boston AQCR		90% Control	90% Control	6/1/74	3/1/76	90% Control[4]	6/1/74	5/31/77
New Jersey	NJ-NY-Conn. Interstate AQCR (NJ portion)		90% Control	90% Control	6/1/74	3/1/76	90% Control[4]	6/1/74	5/31/77
Pennsylvania	Southwest Pa. AQCR (Allegheny County portion)		90% Control	90% Control	6/1/74	3/1/76			
Texas	Houston-Galveston AQCR		90% Control	90% Control[5]	3/31/75	5/31/76	90% Control	3/31/75	5/31/77
	Dallas-Ft. Worth AQCR		90% Control	90% Control[5]	3/31/75	5/31/76	80% Control	3/31/75	6/30/76
	San Antonio AQCR		90% Control	90% Control[5]	3/31/75	5/31/76	90% Control	3/31/75	5/31/77

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TABLE 1.2-3 (Cont.)

VAPOR RECOVERY REGULATIONS FOR SERVICE STATIONS

STATE	TRANSPORTATION CONTROL PLAN*	STATE OR COUNTY REGS	TRUCK LOADING AT TERMINAL**	TRUCK UNLOADING AT SERVICE STATION	COMPLIANCE DATES[a]		AUTO REFUELING	COMPLIANCE DATES[a]	
					INITIAL	FINAL		INITIAL	FINAL
Texas (Cont.)	Austin-Waco AQCR		90% Control	90% Control[5]	7/1/74	5/31/75			
	El Paso-Las Cruces-Alamogordo AQCR (Texas portion)		90% Control	90% Control[5]	7/1/74	5/31/75	80% Control	7/1/74	5/31/75
Virginia	Natl. Capital Interstate (Va. portion)		90% Control	90% Control	6/1/74	3/1/76	90% Control	6/1/74	5/31/77

* The provisions of all the TCP's concerning service station vapor recovery are the same except for the exceptions described in footnotes 2, 4, and 5 below, and for some of the compliance dates for Texas AQCR's.

** All gasoline transfer vapor control regulations in TCP's have a provision which says, "The vapor laden delivery vessel may be refilled only at facilities equipped with a vapor recovery system which can recover at least 90 percent by weight of the organic compounds in the vapors displaced from the delivery vessel during refilling."

***Source of information, Federal Register 38, 30975 (1973).

1. The following California counties are considering service station vapor recovery regulations:

Fresno
Kern

San Joaquin

Sacramento
Yolo-Solano APCD

South Coast Basin Counties of:

Los Angeles
Orange

Riverside
Santa Barbara

San Bernardino
Ventura

2. The following provision appears only in the California TCP: "Facilities that exclusively service delivery vehicles that in turn service storage tanks that do not have a required vapor return or balance system will not be required to have a vapor recovery system."

TABLE 1.2-3 (Cont.)

3. The gasoline transfer vapor control regulation in the Colorado TCP requires that all vapor-laden delivery trucks be refilled only at facilities where the displaced vapors can be removed with 90 percent efficiency. The organic liquid loading regulation in this TCP requires 90 percent collection of vapors during truck loading only at 20,000 gal/day facilities. There seems to be a discrepancy here.

4. The wording of most TCP's concerning the auto refueling vapor collection system says that the system "can consist of a vapor-tight vapor return line from the fill nozzle-filler neck interface to the dispensing tank or to an adsorption, absorption, incineration, refrigeration-condensation system or its equivalent." The word "or" is omitted from the TCP's covering Metropolitan Denver AQCR, Metropolitan Boston AQCR, and NJ-NY-Connecticut Interstate AQCR (NJ portion). The word "or" had been omitted from Texas TCP's, but this omission was corrected in the February 8, 1974, Federal Register.

5. These Texas TCP's require control on stationary storage containers with a capacity greater than 1000 gallons. TCP's in other states require control on containers of greater than 250 gallon capacity.

[a] initial compliance - submittal of plan which describes steps to be taken to achieve compliance with the regulation.

final compliance - complete compliance with the provisions of the regulation.

[b] San Diego requires that all displaced vapor and air be vented to a vapor disposal system where organic vapors are recovered with a 90 percent by weight collection efficiency. Intermediate transfers of vapor, such as vapor return from service station tank to delivery vessels, may require much greater than 90% collection efficiency before the overall vapor disposal for the complete system is 90% efficient. Ninety percent control is interpreted more strictly in San Diego than it is in other jurisdictions.

Source: EPA, Brief Summary of Service Station Vapor Recovery Regulations, 1 May 1974.

reasonably available alternative means of attaining such primary standard. . ." (Clean Air Act of 1970, Section 110(a) (4) (e) (1)). As indicated in Table 1.2-3, the two year extension has been allowed for the implementation of vapor recovery regulations at service stations in some states. In general, Stage I controls, related to the filling of service station tanks are to be implemented by 1 March 1976. Stage II controls, related to the filling of vehicle tanks, are scheduled to be completed by 31 June 1976 if they involve 80% control and 31 may 1977 if they involve 90% control. Compliance dates for Stage II controls are currently under review by EPA.

1.2.7 Standards of Performance for New Stationary Sources

The procedure for establishing standards of performance for new stationary sources is much the same as that for establishing ambient air quality standards. In this case, however, categories of stationary sources are the subject of regulations as opposed to specific pollutants. New or modified sources within the designated categories are expected to achieve the maximum recovery possible with consideration given to industrial processes, their operation, available control systems, and costs.

Thus far, storage and loading facilities at new or modified petroleum refineries are the only gasoline marketing operations under standards of performance for new stationary sources.

2.0 COST DATA

This section presents detailed cost data for the vapor control technology discussed in this report. These costs are subject to continuous escalation. Therefore, dates have been attached to the cost data where possible.

Tables 2.0-1 and 2.0-4 report the capital and installed costs of several tankage vapor controls. At the bottom of Table 2.0-1 are the bases for calculating operating costs as functions of capital costs. Operating costs for tankage controls are reported in Table 2.0-5. Table 2.0-6 presents the differential investment and payout of various tankage controls.

Table 2.0-7 presents the costs of top and bottom loading vapor control equipment for terminal loadings racks. Tank truck vapor recovery equipment costs are presented in Table 2.0-8.

Costs for terminal vapor recovery units are reported in Table 2.0-9 and 2.0-10. Table 2.0-10 also includes vapor holder costs, installation costs, operating costs, and statistics on terminal vapor recovery.

Costs for service station vapor recovery equipment are reported in Tables 2.0-11 through 2.0-14. Table 2.0-11 covers delivery-related vapor recovery equipment for service stations. Table 2.0-12 is concerned with the cost of secondary vapor recovery units. Table 2.0-13 summarizes the cost incurred by eight companies in installing and operating direct displacement systems and Vaporex vapor control systems. The materials, labor, and equipment costs contributing to the installation cost of a direct displacement vapor recovery system are itemized in Table 2.0-14.

TABLE 2.0-1

ESTIMATED INSTALLED COSTS OF STORAGE TANKS

Nominal Tank Capacity, Barrels	50,000	100,000	150,000
Size	90' dia x 48'	120' dia x 48'	150' dia x 48'
Installed Costs, $			
Fixed Roof Tank	161,000	257,000	379,000
Pontoon Floating Roof Tank	176,000	279,000	403,000
Internal Floating Cover in Existing Roof Tank	34,000	54,000	68,000

Operating Cost Bases

Maintenance	@ 2% Capital Cost
Depreciation	@ 10% Capital Cost
Property Taxes	@ 1% Capital Cost
Insurance	@ .5% Capital Cost
Corporate Overhead	@ 3% Plant Level Cost
Gasoline Loss	@ $5.50/Barrel or $.131/gal.

SOURCE: MS-001 (1972)

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TABLE 2.0-2

SOURCES OF COST DATA

VAPOR RECOVERY EQUIPMENT FOR CONE ROOF STORAGE TANKS

Buffalo Tank Div., Bethlehem Steel Co., Supplies Floating pans covers made by others. Price not given.

Chicago Bridge and Iron Co. Weather-type internal float-cover, steel. Vaporphere for four or more tanks. Prices not given.

Graver Tank and Mfg. Co., Div. Envirogenics. Vapor miser, ground-based vapor-collecting tank with bladder-like device. Custom-built to individual storage. Pan-type internal cover of 3/16 in. carbon steel. Turnkey job, depends on size, distance from supply point, labor.

Mayflower Vapor Seal Corp. Vapor Seal internal floating roof of aluminum deck on pontoons. Can be small as 10 ft. diameter up to 285 ft. diameter. Turnkey job, from $1800 for 10 ft. cover, up to $110,000 for 285 ft. cover.

Pittsburgh-Des Moines Steel Co. Hammond-flote II internal floating cover of urethane foam as core covered top and bottom with reinforced fiberglass polyester resin, for 10 to 215 ft. tank diameters. Turnkeys job with price depending on tank size, freight, labor.

Innerflote internal floating cover of 3/16 in. steel plate on upper and lower deck, with center of structural supports. For any diameter tank. Turnkey job, price depending on tank size, freight, labor.

TABLE 2.0-2 (cont.)

Buoyroof (new product), floating roof of steel installed in open tank top. Can be added to cone-roof tank after old roof is removed. Any size tank. Turnkey job, price depending on tank size, freight, labor.

Olin Corp., Aluminum Div., Vaconodeck internal floater (replaces Aludeck floater); aluminum structure covered by aluminum sheeting supported by aluminum pontoons filled with rigid, fire-retardant urethane foam; size from 0 ft. diameter up to 214 ft. Turnkey job, from $1800 to $2500 for 10 ft. tank (depends on shipping charges) to about $80,000 for 214 ft. tank.

Floater cover, fixed roof installed over existing floating roof, aluminum; for tanks 25 to 85 ft. diameter. Turnkey job, prices from $10 sq. ft. for smaller tanks to $16 sq. ft. for higher tanks.

SOURCE: BR-163 (1973)

TABLE 2.0-3

INVESTMENTS - FLOATING ROOF VS. FIXED ROOF TANKS

TANK SIZE		COST TO RETROFIT FIXED ROOF TO:		Δ COST FOR NEW CONSTRUCTION; FLOATING ROOF VS. FIXED ROOF		
DIAMETER (FT.)	CAPACITY (BBL)	COVERED FLOATING ROOF	INTERNAL FLOATING COVER	PONTOON FLOATING ROOF	COVERED FLOATING ROOF	INTERNAL FLOATING ROOF
20	1,100		$ 2,800	-	-	$ 2,800
40	9,000	$17,000	$ 6,500	-	N/A	+$ 7,000
60	22,000	$26,000	$12,000	+$20,000	+$17,000	+$12,000
90	54,000	$42,000	$27,000	+$25,000	+$23,000	+$24,000
110	80,000	$51,000	$40,000	+$27,000	+$33,000	-

SOURCE BU-118 (1973)

TABLE 2.0-4

PURCHASE COST OF STORAGE TANKS

LIQUID VOLUME (bbl)	GRAVIER 5' LIFTER		GRAVIER 10' LIFTER		PONTOON PRICE ($)	DOUBLE DECK PRICE ($)	FIXED ROOF PRICE ($)
	VAPOR VOLUME (cu. ft.)	PRICE ($)	VAPOR VOLUME (cu. ft.)	PRICE ($)			
30,000	21,000	57,000	42,000	67,000	48,000	56,000	36,000
40,000	28,000	68,000	58,000	81,000	58,000	70,000	46,000

SOURCE: (NI-027)

TABLE 2.0-5

SUMMARY OF ESTIMATED OPERATING COSTS FOR GASOLINE STORAGE TANKS

Tank Capacity, Barrels	50,000	100,000	150,000
Annual Operating Costs, $			
Fixed Roof Tank	29,000	48,600	72,200
Pontoon Floating Roof Tank	25,000	39,500	57,100
Internal Floating Cover (In Fixed Roof Tank)	28,600	45,600	66,000
Annual Operating Cost, $/1,000 Barrels			
Fixed Roof Tank	600	490	480
Pontoon Floating Roof Tank	500	400	380
Internal Floating Cover (In Fixed Roof Tank)	570	460	440

SOURCE: MS-001 (1972)

TABLE 2.0-6

DIFFERENTIAL SAVINGS VS DIFFERENTIAL CAPITAL INVESTMENT AND PAYOUT (BASE CASE - FIXED ROOF TANK)

Tank Capacity, Barrels	50,000	100,000	150,000
Pontoon Roof			
Differential Installed Capital Cost, $	15,000	22,000	24,000
Differential Net Savings (Before Tax), $	4,900	9,100	15,100
Differential Tax, A 50%, $	2,450	4,550	7,550
Differential Savings (After Tax), $	2,450	4,550	7,550
Payout After Taxes (yr)	3.80	3.26	2.41
Internal Floating Cover in Existing Fixed Roof Tank			
Differential Installed Capital Cost, $	34,000	54,000	68,000
Differential Net Savings (Before Tax), $	1,300	3,000	6,200
Differential Tax @ 50%, $	650	1,500	3,100
Differential Net Savings (After Tax), $	650	1,500	3,100
Payout After Taxes (yr)	8.40	7.83	6.87

SOURCE: MS-001 (1972)

TABLE 2.0-7
SOURCES OF COST DATA
LOADING RACK VAPOR RECOVERY EQUIPMENT

AMR Div., Aeroquip. Vapor-recovery dome assembly conversion kit for any 4 in. conventional top-loading arm, mechanical seal. $350,000. Top-loading vapor-recovery loading assembly with automatic shutoff, interlocks, pneumatic or hydraulic seal. $2500-$3000.

Chicksan. Div. of FMC Corp., Top-loading vapor-recovery arm, pneumatic control for sealing to hatch. About $3000 for 4 in. arm. involves some custom designing. 6 in. and 3 in. arms also available.

Emco Wheaton. Top-loading vapor-recovery loading assembly, mechanical seal. $1700 FOB. Bottom-loading assembly, metallic hose, $1290. Bottom-loading A-frame assembly, $725. Vapor-recovery coupler, 4 in. $204.

Ever-Tite Coupling Co., Supplies various couplers for loading lines, vapor-recovery. From $1500 FOB, depending on size. Bottom-loading assembly, cross-over type, $1000 FOB per arm. (Does not include vapor-return line.)

Parker Hannifin. loading hose coupler, 4 in., $294.50 list FOB (matching vapor-return line coupler supplied by user). Top-loading tight-fill system. (Includes mechanical manhold seal, loading-hose adaptor, electrical relief valve, vapor-return adaptor, electrical connection for float switch as backup to pre-set meter filling to prevent overfills). $750 list FOB.

SOURCE: BR-163 (1973)

TABLE 2.0-8

SOURCES OF COST DATA FOR TANK TRUCK VAPOR RECOVERY EQUIPMENT

Emco Wheaton	
Vapor-line adaptor, 4 in.	$ 98.00
Vapor-line coupler, 2 in.	30.00
Coaxial loading-vapor coupler	134.00
Slow-flow/fast-flow valve	165.00
Bottom-loading coupler, 4 in.	233.00
Vapor hood, emergency vent	57.00
Ever-Tite Coupling Co.	
Supplies various couplers for delivery hose, vapor-return lines.	
McDonald Mfg. Co.	
Delivery-hose tight-fill connection, 4 in.	60.00
Vapor-return line tight-fill connection, 2 in.	26.00 - 30.00
OPW Div., Dover Corp.	
Vapor-line coupler, 2 in.	69.50
Combined product-vapor coupler, 6 in.	121.50
Single-point product-vapor coupler, 4 in.	121.50
Delivery coupler, tight-fill, 4 in.	50.10
Loading vapor-recovery system	From 80.00 (depending on size)
Parker Hannifin	
Leading-line adaptor, 4 in. List, FOB (user supplies his own vapor-line adaptor).	160.00
Float switch.	Price not given
Emergency vent (includes vent, hood, linkage to internal valve). List, FOB.	185.00
Drop-tube deflector. List, FOB.	11.86
Philadelphia Valve Co.	
Super valve, 4 in., balanced and air-operated, used with automatic high-level shutoff in loading.	473.79
Float valve, air-operated.	157.69
Float switch, magnetic, high-level	83.38
Vent, 5 in., used with 4 in. balanced super valve.	96.06
Hood, vapor collecting, for vent.	79.75
Super valve, 4 in., with 5 in. vent.	435.00
Manhole, spring loaded for 5 in. vent.	188.50

SOURCE: BR-163 (1973)

TABLE 2.0-9
SOURCES OF COST DATA FOR TERMINAL VAPOR RECOVERY UNITS

Gulf Environmental Systems	
Vapor-recovery system, condensing type, skid-mounted, FOB, depending on size plus installation.	$75,000 - 80,000
Parker Hannifin	
Vapor-recovery system, absorption type, skid-mounted, FOB, depending on size, plus $25,000-$80,000 for installation.	$60,000 -175,000
Rheem Superior	
Vapor-recovery system, absorbing type, skid-mounted, FOB, depending on size, plus installation.	$68,000 - 99,000
Southwest Industries, Div. Ingersoll Rand	
Vapor absorption-type convertors. Seven models with capacity to handle vapors in loading from 30,000 gal. daily. Requires extra cost vapor holder. Price not given, but work is done on turnkey basis.	
Vaporex	
Vaporex condensation system, skid-mounted. Requires no vapor-holding tank; biggest unit eliminates need for floating roof on storage. FOB, plus installation.	From $75,000 -200,000
Vaportrol VS-1 system, cooling-condensing type, 4 ton capacity, FOB plus $6000 installation for existing aboveground storage. $2000 FOB, plus about $2500 installation for underground storage.	4,000
AER Corp.	
Custom-built to terminal's product throughput. Capacity range from 50 cfm to 350 cfm. From $20,000 to $50,000, FOB, plus installation.	

SOURCE: BR-163 (1973)

TABLE 2.0-10

COSTS AND STATISTICS FOR TERMINAL VAPOR RECOVERY UNITS (1974)

	Principle	Vapor Holder	Satu-rator	Temp (°F)	Press (psig)	Utility (bhp/MCF)	Efficiency (%)	Unit Cost FOB	Vapor Holder Cost	Maintenance & Operating Cost (% of Capital)	Site Prep-aration & Inst. Cost	Units In Field	Estimated Yearly Capacity	Delivery Time (mo)	Comments
Parker Hannifin	CRA	Yes	Yes	-10	45	7.4-10.7	92-97	130CFM-$90K 525CFM-120K	$16K-100K	2%-3%	$30K-40K	17	252	10	Defrost Cycle
Rheem Superior	CRA	Yes	Yes	32°-amb	115-210	7.4	90-97	90CFM-$81K 160CFM-83K 312CFM-98K 520CFM-127K	$8K-37K	2%-3%		71	36	9	
Gesgo	CRC	Yes	Yes	15°-30°	410	8-14.5	90-96	$75K-85K		3%		17	12	10-12	
Vaporex	CRC	No	Yes	-10	6[illegible]		90-96	150 mgpd-$150K 200 mgpd-$175K	None	2%-3%	$5000-5500	2	25	8-9	Methanol Injection
Edwards	Ref.	No	No	-100	atm	9.4	93-98	25 mgpd-$31K 250 mgpd-$85K 1000 mgpd-$160K	None	2%		2	52	6	Cost of Transportation $500-1500 Defrost Cycle
Southwest Industries	LOA	No	No	amb	atm		90-95		None	2%-3%		30	60	6	
AER	Flame Oxidation	Yes	Yes		atm		98-99	50CFM-$12K 200CFM-$50K				18	30	4	

TABLE 2.0-11
SOURCES OF COST DATA FOR DELIVERY-RELATED SERVICE STATION VAPOR RECOVERY EQUIPMENT

Emco Wheaton	
Submerged fill tube, 4 in. x 10 ft.	$15.00
Dry-break adaptor, vapor return.	16.50
Vapor adaptor cap.	12.00
Overfill protection valve.	44.00
Multiple-access tank unit.	36.00
Pressure-vacuum vent.	12.25
Manhold 9 in., 12 in.	10.40 - 14.75
Extractable float valve.	Price not set
Coaxial adaptor, tube.	58.00
Ever-Tite Coupling Co.	
Supplies various adaptors for delivery, vapor-return lines.	
McDonald Mfg. Co	
Fill cap assembly (can also be used for vapor-return line cap assembly).	15.00
Pressure-vacuum vent.	15.00
OPW Div., Dover Corp.	
Combined liquid and vapor-return line adaptor, 4 in.	Under 50.00
Same as above, 6 in.	Under 50.00
Vapor-return adaptor, tank.	From 32.50
Float valve, vent-line manifold.	33.50
Extractor vent valve assembly with float valve.	66.20
Float valve only.	13.25
Vapor-line recovery adaptor for above-ground manifold.	56.50
Manhold, 9 in., 12 in.	12.80 - 18.70
Drop tube, 4 in. x 10 ft.	18.45

SOURCE: BR-163 (1973)

TABLE 2.0-12

COSTS FOR SERVICE STATION VAPOR RECOVERY UNITS

Atlantic Engineering

Mark I Intermark vapor recovery system, condensing type, $5000 FOB, plus $2500 installation at existing stations. (Includes vapor-recovery gasoline nozzles.) Nozzle, vapor-recovery type, $20-25 installed.

Vaporex

Vaportrol VS-1 system, cooling-condensing type, 1 ton capacity, $1500 FOB, plus about $2500 installation at existing stations, $500 installation at new stations.

SOURCE: BR-163 (1973)

TABLE 2.0-13

COST SUMMARY FOR DIRECT DISPLACEMENT AND VAPOREX VAPOR CONTROL SYSTEMS

	A	B	C	D*	E*	F
	Modify Existing Station: Tanks & U.G. Piping System	Incremental Cost - New Station: Tanks & U.G. Piping System	Cost - All Aboveground Equipment Modif. & Nozzles	Cost To Equip Existing Station (A+C)	Incremental Cost To Equip New Station (B+C)	Annual Maint. Cost
Arco						
Materials } Labor	$4,500*	— — }	$1,500*	$6,000	—	—
Maintenance	—	—	—			
Std-Cal						
Materials	526	526	690	5,476	$1,276	$. 130
Labor	4,200	—	60			
Maintenance	0	0	130			
Mobil						
Materials	2,310	550	810	4,615	1,690	—
Labor	1,165	—	330			
Maintenance	—	—	—			
Exxon						
Materials	1,405	1,405	600	5,005	2,005	280
Labor	3,000	—	—			
Maintenance	220	220	60			
Shell						
Materials	1,850	1,850	720	5,000	2,950	620
Labor	2,050	—	380			
Maintenance	100	100	520			
Sunoco						
Materials	2,500	1,500	410	4,570	2,070	450
Labor	1,500	—	160			
Maintenance	100	—	350			
Citgo						
Materials	2,250	2,000	990	7,450	3,350	215
Labor	3,850	—	360			
Maintenance	25	25	180			
Union (Vaporex)						
Materials	3,000	2,900	800	9,800	8,400	—
Labor	5,300	4,000	700			
Maintenance	—	—	—			
Std-Cal (Vaporex)						
Materials	4,026	4,026	1,590	12,646	8,446	535**
Labor	6,700	2,500	330			
Maintenance	125	125	225			

* Materials and labor only

** Includes estimated annual operating cost of $185 (electricity)

SOURCE: SC-186 (1974)

TABLE 2.0-14

ESTIMATE FOR THE INSTALLATION OF A SIMPLE DISPLACEMENT SYSTEM AT TYPICAL SERVICE STATION

MATERIAL	COST
Piping 2" galvanized @ $1.25/ft. x 400'	$ 500.00
Fittings @ $.25/ft.	100.00
Installation @ $2.90/ft.	1,160.00
Excavation	
Sawcut concrete @ $1.50/ft. x 150'	225.00
Tanks @ $150/tank (4 tanks)	600.00
Islands @ 150/island (3 islands)	450.00
Driveways	500.00
Backfill - Sand & Mat	150.00
Labor	350.00
Concrete Work @ Island @ $75.00/island	225.00
@ tanks @ $100.00/tank	300.00
Miscellaneous Fittings-Adapters, Manholes, etc.	200.00
Asphalt Patching	375.00
Testing of Pipes	200.00
Clean Up	150.00
	$5,485.00
Say	$5,500.00
6 vapor recovery nozzles completely installed inc. hose and modifications to dispensers 6 @ $250.00 each.	$1,500.00
Total System Complete	$7,000.00

SOURCE: AR-047 (1974)

3.0 SEASONAL EFFECTS ON VAPOR RECOVERY EFFICIENCIES

Concern has been expressed over the possibility that the efficiency of vapor recovery units will markedly decrease in winter months due to the high concentration of light ends in winter gasoline vapors. Discussed below are the results from simulations of a refrigeration vapor recovery unit where the effects of hydrocarbon concentration and seasonal blending were studied. Although a refrigeration vapor recovery unit was chosen, the results and conclusions should also apply to CRA, CRC, and LOA units.

3.1 Gasoline Composition Bases

Table 3.1-1 contains the liquid composition of a typical 13 RVP winter gasoline (AM-078). Flash calculations were performed on the winter gasoline at 40°F, assuming a vapor to liquid ratio of three, to determine the equilibrium vapor composition.

The composition of vapor from typical summer gasoline was estimated by averaging the compositions of vapors from ten summer gasolines reported by Scott Research Laboratories (SC-186). This composition is given in the third column of Table 3.1-1.

3.2 Calculation Bases

The summer and winter vapor compositions reported in Table 3.1-1 were used in a vapor-liquid equilibrium model to calculate the effects of seasonal gasoline composition changes on vapor recovery unit efficiencies. The model used for calculations was a refrigeration vapor recovery unit operating at

TABLE 3.1-1

SEASONAL COMPOSITIONS OF GASOLINE AND ITS VAPORS IN MOLE PERCENT

	Winter Gasoline		
	Liquid Composition	Calculated Vapor(1) Composition	Average of Summer Vapor(2) Compositions
Air	-	76.2	58.4
C_4	12.8	15.1	20.9
C_5	23.3	7.0	13.6
C_6	14.1	1.1	7.1
C_7	19.6	0.5	-
C_8	17.2	0.1	-
C_9	6.5	-	-
C_{10}	6.5	-	-
Total	100.0	100.0	100.0
RVP	13.0	-	-
Temp., °F	-	40	80

(1) Vapor in equilibrium with liquid assuming a vapor to liquid ratio of 3.0 at 40°F.

(2) Average of ten typical compositions (SC-186).

atmospheric pressure and -100°F coil temperature. Four cases were studied; winter vapor compositions containing 15 mole % and 40 mole % hydrocarbons in the vapor, and summer vapor compositions containing 15 mole % and 40 mole % hydrocarbons in the vapor. Various amounts of air were added to or subtracted from the winter and summer vapor compositions presented in Table 3.1-1 to synthesize the four case inputs listed in Table 3.2-1. The resulting outlet vapor compositions for the four calculated cases are also presented in the table. Vapor recoveries ranged from 93.5% for winter vapors with lower hydrocarbon content to 98.6% for summer vapors with higher hydrocarbon content.

The equations for calculating recovery efficiency from mass rates and hydrocarbon concentrations are presented below.

$$\text{efficiency} = \frac{M_i - M_o}{M_i} \times 100 \qquad (3\text{-}1)$$

$$\text{efficiency} = \frac{N_i - N_o(1-N_i/1-N_o)}{N_i} \times 100 \qquad (3\text{-}2)$$

M_i = hydrocarbon mole rate in
M_o = hydrocarbon mole rate out
N_i = hydrocarbon mole fraction in
N_o = hydrocarbon mole fraction out.

3.3 Conclusions

The hydrocarbon concentrations in the outlet streams from the refrigeration system model are essentially identical for all cases. It is concluded that at a given temperature

TABLE 3.2-1

INPUTS AND RESULTS FROM THE VAPOR-LIQUID EQUILIBRIUM MODEL OF A REFRIGERATION VAPOR RECOVERY UNIT

	Mole(1)			
	Winter Vapors		Summer Vapors	
Inlet Vapors	Case 1	Case 2	Case 3	Case 4
C_4	9.5	25.4	7.5	20.0
C_5	4.4	11.8	4.9	13.2
C_6	0.7	1.8	1.7	4.4
C_7	0.3	0.8	0.9	2.4
C_8	0.1	0.2	0.0	0.0
Air	85.0	60.0	85.0	60.0
Total	100.0	100.0	100.0	100.0
Outlet Vapors				
C_4	1.1	1.1	0.9	0.9
C_5^+	0.03	0.04	0.04	0.05
Air	98.9	98.8	99.1	99.1
Total	100.03	99.94	100.04	100.05
Recovery Percent	93.5	98.2	94.9	98.6

(1) Vapor compositions are based on assuming 15 mole percent hydrocarbons in Cases 1 and 3, 40 mole percent hydrocarbons in Cases 2 and 4. Equilibrium conditions in all cases are atmospheric pressure and -100°F.

and pressure, the concentration of hydrocarbons in the exhaust from a vapor recovery unit is fixed and independent of the inlet hydrocarbon concentration.

Although the inlet hydrocarbon concentration does not control the outlet hydrocarbon concentration, it does have a direct effect on the removal efficiency. Equations 3-1 and 3-2 indicate that the hydrocarbon recovery efficiency of a vapor recovery unit is directly proportional to the total hydrocarbon concentration in the inlet vapors. Higher recovery efficiencies are therefore to be expected with vapors containing higher hydrocarbon concentrations.

Seasonal effects on the efficiency of vapor recovery units are made evident by comparing the outlet vapors of Case 1 to Case 3 and of Case 2 to Case 4 in Table 3.2-1. Recovery of winter vapors, which contain more butanes than summer vapors, is slightly more difficult. However, these changes in the hydrocarbon composition of vapors due to summer and winter blending changes have less effect on the efficiency of vapor recovery units than do changes in the total hydrocarbon concentration. This is attributed to the fact that gasoline vapors are consistently high in butanes and pentanes and the content of these components change very little as the gasoline RVP changes.

In summary:

1) The hydrocarbon concentration in the vent from vapor recovery units is essentially independent of the inlet hydrocarbon concentration to the unit.

2) The hydrocarbon recovery efficiency of vapor recovery unit, at a given set of operating conditions, is directly proportional to the inlet hydrocarbon concentration.

3) The seasonal effect (of gasoline composition) on vapor recovery unit efficiency is small. Recoveries can be expected to be slightly higher in the summer.

4.0 ENFORCEMENT MONITORING

A procedure for monitoring emissions from a stationary source must be specified as part of the technical support document. For the transportation industry, separate monitoring procedures may prove to be needed for each segment of the distribution process; that is for terminals, bulk plants, and service stations. Since enforcement monitoring is definitely an unresolved issue at this time, this section will serve primarily to focus upon factors that need to be considered in developing an enforcement monitoring procedure.

The purpose of enforcement monitoring is to determine whether or not a source is complying with a regulation. Monitoring procedure requirements, therefore, may vary with the type of regulation. This is to say that a regulation based on a percentage control may require a different monitoring procedure than would a regulation based on either mass emission standards or equipment standards. Other factors to be considered are the simplicity, reliability, and accuracy of the enforcement monitoring procedure.

4.1 Terminals

The regulations governing emissions from terminals will probably be based on either a percent recovery or mass emission limit. Monitoring procedures would therefore be designed to measure the necessary parameters to determine compliance with these regulations.

The simplest monitoring procedure for terminal vapor recovery systems would be to measure the hydrocarbon concentrations in the inlet and outlet vapors. The difference in the concentrations could be used to calculate the recovery efficiency. This method is simple, quick, and relatively inexpensive to perform, however, it will not reveal whether or not the system has internal leaks.

An alternative method for enforcement monitoring of terminals includes measurement of the volume and hydrocarbon and air concentration of vapors emitted from the tank truck and from the vapor recovery system. These data can then be used to calculate either percent recovery efficiencies or mass emissions. This method is slightly more involved than the previous method, but it would provide data to reveal the presence of internal leaks in the vapor recovery system.

Monitoring of these systems is still in the development stage. As data is developed, emission factors may be developed that could eliminate the need of measuring some of the above parameters. For example, tests to determine the amount of vapor returned from loading operations may produce factors that could be used reliably to predict the volume of vapor emitted per gallon of fuel loaded for bottom loading and top loading operations. Development and use of these factors would be a practical approach to monitoring operations.

4.2 Service Stations

Regulations governing emissions from service stations could possibly be based on an equipment standard, on a mass standard, or on a percent recovery standard. An equipment standard could either be implemented as part of Stage I or Stage II standard for displacement systems. An enforcement monitoring procedure would not be necessary with this standard. Periodic visits to the source may be necessary to insure that the equipment is in good working order.

A regulation based on either mass emission or percent recovery would require a rather detailed monitoring procedure to evaluate compliance of vapor recovery systems in use today. Losses at the nozzle-fill neck interface for both displacement and vacuum assist systems should be determined to evaluate compliance with regulations. The determination of these nozzle-fill neck interface losses have thus far been accomplished only by indirect methods, and then only for the displacement system; considerable test development work remains to be done in this area.

In addition to measuring losses from nozzles, losses from the vapor recovery system itself must be measured. Monitoring procedures which would determine the volume and hydrocarbon concentrations of the inlet and outlet vapor streams should be performed to provide data upon which to evaluate efficiencies.

A testing program to provide data certifying compliance on a station-by-station basis would be extremely expensive and perhaps unrealistic. Most such procedures would require several days of testing in addition to follow-up analysis. A mechanical specification therefore appears to be the more practical approach.

4.3 Bulk Stations

Bulk station vapor recovery standards could possibly be in the form of an equipment specification, a mass emission limit, or a percent recovery. As with service stations, a standard based on equipment specifications would require no enforcement testing as long as the proper equipment was installed.

A mass emission or percent recovery standards would require the same testing procedures required at service stations and terminals to certify compliance.

5.0 PHYSICAL AND CHEMICAL PROPERTIES OF GASOLINE AND ITS VAPORS

The chemical and physical properties of gasoline and the vapors emitted from gasoline handling facilities are described in this section. Special attention has been given to the particular properties of gasoline and emitted vapors that are considered critical in assessing the impact on air quality.

5.1 Chemical Composition of Gasoline

Motor gasolines are blends of petroleum distillates carefully combined to yield the proper volatility and combustion characteristics for good motor performance. Their composition is complex and varies greatly with the sources of crude oil from which it was distilled and with the types of conversion processes to which it has been subjected. Gasoline compositions also vary greatly because the temperatures and altitudes at which gasolines are used vary, and the gasoline blends must be altered to ensure proper fuel volatility and car performance at each locale and for each season. Table 5.1-1 (MA-291) and Table 5.1-2 (AM-078) detail the chemical compositions of several full range premium gasolines. For simplicity Table 5.1-3 summarizes data from Table 5.1-1 and Table 5.1-2. The characteristics of typical summer and winter gasoline blends are contrasted in Table 5.1-4 (SH-137) and Table 5.1-5 (SH-138). The compositions of the gasolines in these two tables are expressed by means of boiling fractions.

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TABLE 5.1-1

DETAILED CHEMICAL COMPOSITION OF A FULL RANGE MOTOR GASOLINE

Component	Boiling Point, °C*	Composition, % wt
Propane	−42.07	0.01
Isobutane	−11.73	0.37
Isobutylene	−6.90	0.04
+ Butene-1	−6.26	
n-Butane	−0.50	4.29
Trans-2-butene	0.88	0.20
Neopentane	9.50	0.04
Cis-2-butene	3.72	0.17
3-Methyl-1-butene	20.05	0.12
Isopentane	27.85	10.17
Pentene-1	29.97	0.45
2-Methyl-1-butene	31.16	0.22
2-Methyl-1,3-butadiene	34.07	
n-Pentane	36.07	5.75
Trans-2-pentene	36.35	0.90
Cis-2-pentene	36.94	0.67
2-Methyl-2-butene	38.57	0.96
3,3-Dimethyl-1-butene	41.24	
2,2-Dimethylbutane	49.74	0.46
Cyclopentene	44.24	0.18
3-Methyl-1-pentene	54.14	
+ 4-Methyl-1-pentene	53.88	0.18
4-Methyl-cis-2-pentene	56.30	0.04
2,3-Dimethyl-1-butene	55.67	0.08
Cyclopentane	49.26	0.51
2,3-Dimethylbutane	57.99	1.55
+ (4-Methyl-trans-2-pentene)*	58.55	0.18
2-Methylpentane	60.27	3.76
2-Methyl-1-pentene	60.72	0.22
3-Methylpentane	63.28	2.23
+ (Hexene-1)	63.49	
+ (2-Ethyl-1-butene)	64.66	
Cis-3-hexene	66.47	0.11
Trans-3-hexene	67.08	0.12
3-Methylcyclopentene	65.0	0.04
2-Methyl-2-pentene	67.29	0.27
3-Methyl-cis-2-pentene	67.70	0.37
n-Hexane	68.74	1.51
+ (4,4-Dimethyl-1-pentene)	72.49	
Trans-2-hexene	67.87	0.18
Cis-2-hexene	68.84	0.15
3-Methyl-trans-2-pentene	70.44	0.34
4,4-Dimethyl-trans-2-pentene	76.75	Trace
Methylcyclopentane	71.81	
+ (3,3-Dimethyl-1-pentene)	77.57	0.62
2,2-Dimethylpentane	79.20	
+ 2,3-Dimethyl-2-butene	73.21	
+ (2,3,3-Trimethyl-1-butene)	77.87	0.14
Benzene	80.10	0.81
2,4-Dimethylpentane	80.50	1.71
4,4-Dimethyl-cis-2-pentene	80.42	
2,2,3-Trimethylbutane	80.88	0.04
2,4-Dimethyl-1-pentene	81.64	0.03
1-Methylcyclopentene	75.8	
+ 2-Methyl-cis-3-hexene	86	0.32
2,4-Dimethyl-2-pentene	83.26	
+ 3-Ethyl-1-pentene	84.11	
+ 3-Methyl-1-hexene	84	0.05
2,3-Dimethyl-1-pentene	84.28	0.02
2-Methyl-trans-3-hexene	86	
+ 5-Methyl-1-hexene	85.31	0.04
3,3-Dimethylpentane	86.06	0.02
Cyclohexane	80.74	
+ (4-Methyl-cis-2-hexene)	87.31	0.17
4-Methyl-1-hexene	86.73	
+ 4-Methyl-trans-2-hexene	87.56	0.09
3-Methyl-2-ethyl-1-butene	86.1	0.02
5-Methyl-trans-2-hexene	88.11	0.02
Cyclohexene	82.98	0.03
2-Methylhexane	90.05	
+ (5-Methyl-cis-2-hexene)	89.5	1.48
2,3-Dimethylpentane	87.78	
+ (1,1-Dimethylcyclopentane)	87.85	
+ (3,4-Dimethyl-cis-2-pentene)	87.9	4.17
3-Methylhexane	91.85	1.77
1-Cis-3-dimethylcyclopentane	91.73	
+ 2-Methyl-1-hexene	91.95	
+ 3,4-Dimethyl-trans-2-pentene	90.5	0.27
1-Trans-3-dimethylcyclopentane	90.77	
+ 1-Heptene	93.64	
+ 2-Ethyl-1-pentene	94	0.27
3-Ethylpentane	93.48	
+ 3-Methyl-trans-2-hexene	94	0.16
1-Trans-2-dimethylcyclopentane	91.87	0.16
2,2,4-Trimethylpentane	99.24	
+ (Trans-3-heptene)	95.67	4.58
Cis-3-heptene	95.75	0.16
3-Methyl-cis-3-hexene	95.3	
+ 2-Methyl-2-hexene	95.44	
+ 3-Methyl-trans-3-hexene	93.53	0.31
3-Ethyl-2-pentene	96.01	0.04
Trans-2-heptene	97.95	0.06
n-Heptane	98.43	
+ (3-Methyl-cis-2-hexene)	94	1.96
2,3-Dimethyl-2-pentene	97.40	
+ Cis-2-heptene	98.5	0.12
1-Cis-2-dimethylcyclopentane	99.57	0.09
Methylcyclohexane	100.93	
+ 2,2-Dimethylhexane	106.84	
+ 1,1,3-Trimethylcyclopentane	104.89	0.31
2,5-Dimethylhexane	109.10	
+ Ethylcyclopentane	103.47	0.60
2,4-Dimethylhexane	109.43	0.50
2,2,3-Trimethylpentane	109.84	0.23
1-Trans-2-cis-4-trimethylcyclopentane	109.29	0.04
Toluene	110.63	12.20
3,3-Dimethylhexane	111.97	0.10
1-Trans-2-cis-3-trimethylcyclopentane	110.2	0.06
2,3,4-Trimethylpentane	113.47	2.26
2,3,3-Trimethylpentane	114.76	2.28
1,1,2-Trimethylcyclopentane	113.73	0.09
2,3-Dimethylhexane	115.61	
+ 2-Methyl-3-ethylpentane	115.65	0.60
2-Methylheptane	117.65	0.48
4-Methylheptane	117.71	0.22
3,4-Dimethylhexane	117.73	
+ (1-Cis-2-trans-4-trimethylcyclopentane)	116.73	0.16
3-Ethylhexane	118.53	0.01
3-Methylheptane	118.93	
+ (3-Methyl-3-ethylpentane)	118.26	0.63
1,1,3-Trans-4-tetramethylcyclopentane	121.6	
2,2,5-Trimethylhexane	124.08	
+ (1-Cis-2-cis-4-trimethylcyclopentane)	118	0.74
1,1-Dimethylcyclohexane	119.54	
+ 1-Trans-4-dimethylcyclohexane	119.35	0.14
1-Cis-3-dimethylcyclohexane	120.09	0.03
1-Methyl-trans-3-ethylcyclopentane	120.8	0.06
2,2,4-Trimethylhexane	126.54	0.11
1-Methyl-trans-2-ethylcyclopentane	121.2	
+ 1-Methyl-cis-3-ethylcyclopentane	121.4	0.07
Cycloheptane	118.79	0.03
1-Methyl-1-ethylcyclopentane	121.52	0.02
1-Trans-2-dimethylcyclohexane	123.42	
+ 1-Cis-2-cis-3-trimethylcyclopentane	123.0	0.12
n-Octane	125.67	0.38
1-Cis-4-dimethylcyclohexane	124.32	0.04
1-Trans-3-dimethylcyclohexane	124.45	0.08
2,4,4-Trimethylhexane	130.65	0.02
Isopropylcyclopentane	126.42	0.01
2,3,3-Trimethylhexane	131.34	0.15

TABLE 5.1-1 (Cont.)

Component	Point, °C	% wt
2,3-Dimethylheptane	132.69	0.01
1-Methyl-cis-2-ethylcyclopentane	128.75	0.07
2,4-Dimethylheptane	133.5	
+ 2,2,3-Trimethylhexane	133.6	0.08
2,2-Dimethyl-3-ethylpentane	133.83	
+ 2-Methyl-4-ethylhexane	133.8	0.07
2,6-Dimethylheptane	135.21	
+ (1-Cis-2-dimethylcyclohexane)	129.73	0.07
n-Propylcyclopentane	130.95	0.01
Ethylcyclohexane	131.78	0.17
2,5-Dimethylheptane	136.0	
+ 3,5-Dimethylheptane	136.0	0.16
Ethylbenzene	136.19	1.70
2,4-Dimethyl-3-ethylpentane	136.73	0.03
3,3-Dimethylheptane	137.3	0.04
1,1,3-Trimethylcyclohexane	136.63	
2,3,3-Trimethylhexane	137.68	0.05
1-Cis-3-cis-5-trimethylcyclohexane	138.41	
2-Methyl-3-ethylhexane	138.0	0.04
p-Xylene	138.35	1.58
m-Xylene	139.10	
+ (3,3,4-Trimethylhexane)	140.46	3.83
2,3-Dimethylheptane	140.5	0.13
3,4-Dimethylheptane	140.6	0.07
4-Methyloctane	142.48	0.11
2-Methyloctane	143.26	0.14
3-Ethylheptane	143.0	0.02
3-Methyloctane	144.18	0.60
o-Xylene	144.41	
+ (2,2,4,5-tetramethylhexane)	147.88	1.93
2,2,4-Trimethylheptane	147.8	0.17
2,2,5-Trimethylheptane	148	
+ 2,2,6-Trimethylheptane	148	0.27
2,5,5-Trimethylheptane	152.80	
+ 2,4,4-Trimethylheptane	153	0.21
Isopropylbenzene	152.39	0.10
n-Nonane	150.80	0.14
3,3,5-Trimethylheptane	155.68	0.02
2,4,5-Trimethylheptane	157	
+ 2,3,5-Trimethylheptane	157	0.17
n-Propylbenzene	159.22	0.24
2,2,3,3-Tetramethylhexane	160.31	
+ 2,6-Dimethyloctane	158.54	0.06
1-Methyl-3-ethylbenzene	161.31	0.83
1-Methyl-4-ethylbenzene	161.99	0.42
3,3,4-Trimethylheptane	164	
+ 3,4,4-Trimethylheptane	164	
+ 3,4,5-Trimethylheptane	164	0.35
1-Methyl-2-ethylbenzene	165.15	
+ 5-Methylnonane	165.1	0.34
4-Methylnonane	165.7	0.04
1,3,5-Trimethylbenzene	164.72	0.39
2-Methylnonane	166.8	0.06
tert-Butylbenzene	169.12	0.01
Unidentified C_{10} alkylate peak		
3-Methylnonane	167.8	0.06
1,2,4-Trimethylbenzene	169.35	1.61
sec-Butylbenzene	173.31	0.01
Isobutylbenzene	172.76	0.01
1-Methyl-3-isopropylbenzene	175.14	0.03
n-Decane	174.12	0.08
1,2,3-Trimethylbenzene	176.08	
+ 1-Methyl-4-isopropylbenzene	177.10	0.32
1-Methyl-2-isopropylbenzene	178.15	
+ Indane	177	0.15
1,3-Diethylbenzene	181.10	0.08
Unidentified C_{11} alkylate peak		
1-Methyl-3-n-propylbenzene	181.80	0.16
n-Butylbenzene	183.27	0.05
1,2-Diethylbenzene	183.42	
+ 1,4-Diethylbenzene	183.30	
+ 1-Methyl-4-n-propylbenzene	183.75	0.09
1-Methyl-2-n-propylbenzene	184.80	0.05
1,3-Dimethyl-5-ethylbenzene	183.75	0.18
Unidentified C_{11} alkylate peak		
2-Methylindane	184	0.02
1,4-Dimethyl-2-ethylbenzene	186.91	0.09
1-Methylindane	186.5	0.07
1-Methyl-3-tert-butylbenzene	189.26	
+ Unidentified C_{11} alkylate peak		0.03
1,3-Dimethyl-4-ethylbenzene	188.41	0.13
1,3-Dimethyl-2-ethylbenzene	190.01	
+ 1,2-Dimethyl-4-ethylbenzene	189.75	0.19
1-Methyl-4-tert-butylbenzene	192.76	0.04
1,2-Dimethyl-3-ethylbenzene	193.91	0.03
n-Undecane	195.89	0.07
1,2,4,5-Tetramethylbenzene	196.8	0.10
1,2,3,5-Tetramethylbenzene	188.0	0.17
Isopentylbenzene	198.9	0.07
5-Methylindane	199	0.11
4-Methylindane	203	0.03
n-Pentylbenzene	205.46	0.03
1,2,3,4-Tetramethylbenzene	205.4	0.03
Tetralin	205.57	0.02
Naphthalene	217.96	0.10
1,3-Dimethyl-5-tert-butylbenzene	205.1	0.02
n-Dodecane	216.28	0.05

TABLE 5.1-2
AVERAGE COMPOSITION OF 15 SAMPLE MOTOR GASOLINES

Component	% wt.
Saturates:	
Methane	...
Ethane	...
Isobutane	1
n-butane	7
Isopentane	10
n-pentane	4
2,3-dimethylbutane	2
2-methylpentane	3
3-methylpentane	2
n-hexane	2
Methylcyclopentane	1
2,4-dimethylpentane	2
Cyclohexane	1
2-methylhexane	5
2,2,4-trimethylpentane	6
n-heptane	1
Methylcyclohexane	1
2,4-dimethylhexane	1
2,3,4-trimethylpentane	2
2,3,3-trimethylpentane	1
2-methyl-3-ethylpentane	1
3,4-dimethylhexane	1
2,2,5-trimethylhexane	1
n-octane	1
Other saturates	6
Olefins and acetylenes:	
Ethylene	...
Propylene	...
Isobutylene/1-butene	...
2-butene	...
2-methyl-1-butene	1
2-pentene	1
2-methyl-2-butene	2
2-methyl-2-pentene	1
1,3-butadiene	...
2-methyl-1,3-butadiene	...
Acetylene	...
Methylacetylene	...
Other olefins	6
Aromatics:	
Benzene	1
Toluene	6
Ethylbenzene	1
m- and *p*-xylene	5
o-xylene	2
n-propylbenzene	1
1-methyl-4-ethylbenzene	1
1,3,5-trimethylbenzene	1
1-methyl-2-ethylbenzene	1
1,2,4-trimethylbenzene	3
1,2,3-trimethylbenzene	1
Other aromatics	4

TABLE 5.1-3

COMPOSITION SUMMARY OF TYPICAL PREMIUM GASOLINES

Component	Composition % wt Table 3.9-1	 Table 3.9-2
Saturates	62	62
Olefins & Acetylenes	9	11
Aromatics	29	27
	100%	100%

C_4	8
C_5	18
C_6	13
C_7	15
C_8	21
C_9	9
Other	16
	100%

TABLE 5.1-4

SUMMARY OF VALUES, MOTOR GASOLINE SURVEY, WINTER 1971-72

Test	ASTM method	Regular-price gasoline Average	Premium-price gasoline Average
Gravity, °API	D287	62.7	62.9
Corrosion, No.	D130	1	1
Sulfur content, wt %	D1266	0.044	0.026
Gum, mg/100 ml	D381	1	1
Lead, g/gal	D526	1.88	2.43
Octane number, Research	D2699	94.0	99.8
Octane number, Motor	D2700	86.5	92.3
Reid vapor pressure, lb	D323	12.1	12.1
Distillation	D86		
Temp, °F			
IBP		84	83
5% evaporated		96	95
10% Do.		108	109
20% Do.		128	132
30% Do.		150	158
50% Do.		199	209
70% Do.		255	253
90% Do.		336	321
95% Do.		369	353
End point		408	398
Residue, vol %		1.0	0.9
Loss, vol %		2.1	2.4

SUMMARY OF VALUES, MOTOR GASOLINE SURVEY, WINTER 1970-71

Test	ASTM method	Regular-price gasoline Average	Premium-price gasoline Average
Gravity, °API	D287	63.1	62.6
Corrosion, No.	D130	1	1
Sulfur content, wt %	D1266	0.039	0.023
Gum, mg/100 ml	D381	1	1
Lead, g/gal	D526	2.02	2.60
Octane number, Research	D2699	93.9	99.8
Octane number, Motor	D2700	86.4	92.2
Reid vapor pressure, lb	D323	12.1	12.1
Distillation	D86		
Temp, °F			
IBP		84	83
5% evaporated		95	95
10% Do.		108	109
20% Do.		127	132
30% Do.		149	158
50% Do.		197	210
70% Do.		253	253
90% Do.		335	321
95% Do.		368	353
End point		406	396
Residue, vol %		1.0	1.0
Loss, vol %		2.1	2.3

TABLE 5.1-5

SUMMARY OF VALUES, MOTOR GASOLINE SURVEY, SUMMER 1973

Test	ASTM method	Regular-price gasoline	Premium-price gasoline
		Average	Average
Gravity, °API	D287	60.3	61.7
Corrosion, No.	D130	1	1
Sulfur content, wt %	D1266	0.040	0.026
Gum, mg/100 ml	D381	1	1
Phosphorus, g/gal	D3231	0.004	0.003
Lead, g/gal	D526	2.01	2.42
Octane number, Research	D2699	93.5	99.3
Octane number, Motor	D2700	86.1	91.9
Research + motor octane Nos./2		89.8	95.6
Reid vapor pressure, lb	D323	9.3	9.5
Vapor-liquid ratio of 20, °F	D439	136	137
Distillation	D86		
Temp, °F			
IBP		91	90
5% evaporated		108	107
10% Do.		121	121
20% Do.		142	146
30% Do.		163	171
50% Do.		211	215
70% Do.		265	255
90% Do.		342	325
95% Do.		373	361
End point		417	405
Residue, vol %		1.0	1.0
Loss, vol %		1.6	1.7

SUMMARY OF VALUES, MOTOR GASOLINE SURVEY, SUMMER 1972

Test	ASTM method	Regular-price gasoline	Premium-price gasoline
		Average	Average
Gravity, °API	D287	60.5	60.7
Corrosion, No.	D130	1	1
Sulfur content, wt %	D1266	0.042	0.026
Gum, mg/100 ml	D381	1	1
Phosphorus, g/gal	D3231	-	-
Lead, g/gal	D526	2.04	2.52
Octane number, Research	D2699	94.1	99.8
Octane number, Motor	D2700	86.4	92.2
Research + motor octane Nos./2		90.3	96.0
Reid vapor pressure, lb	D323	9.2	9.3
Vapor-liquid ratio of 20, °F	D439	-	-
Distillation	D86		
Temp, °F			
IBP		92	91
5% evaporated		108	108
10% Do.		122	123
20% Do.		142	147
30% Do.		163	172
50% Do.		208	217
70% Do.		262	257
90% Do.		339	324
95% Do.		372	357
End point		411	401
Residue, vol %		0.9	0.9
Loss, vol %		1.5	1.6

5.2 Reid Vapor Pressure of Gasoline

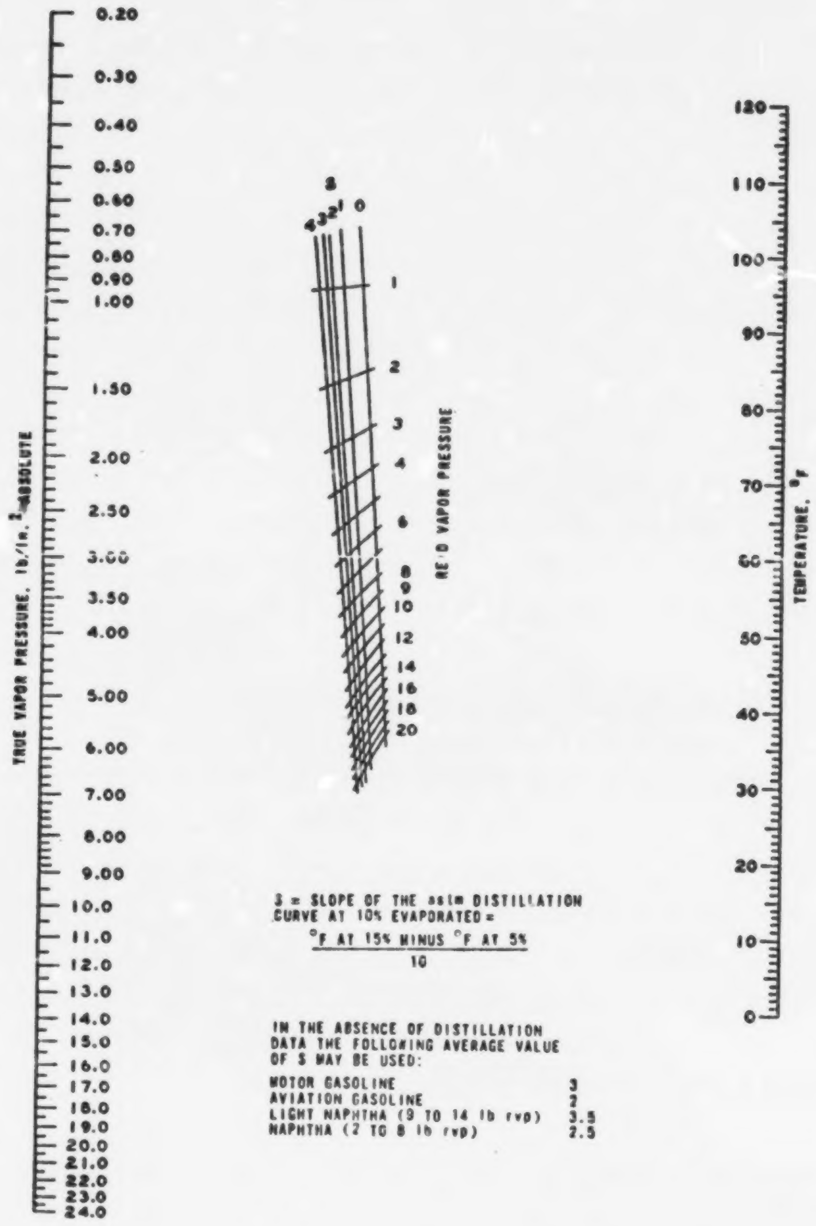
Gasoline is often characterized by Reid Vapor Pressure (RVP), a technique developed as a means of expressing the vapor pressure or volatility of petroleum fractions. This is a fundamental property in the study of hydrocarbon emissions from gasoline marketing facilities. Figure 5.2-1 (DA-004) correlates Reid Vapor Pressure with true vapor as a function of temperature. In the absence of distillation data, the value of S (the slope of the ASTM distillation curve at 10% evaporation) may be estimated as three for motor gasolines. Seasonal and locational variations in Reid Vapor Pressures and several other gasoline characteristics for both premium and regular grades are presented in Table 5.2-1 (SH-137) and Table 5.2-2 (SH-138). Districts to which these tables refer are shown in Figure 5.2-2 (SH-137).

5.3 Chemical Composition of Gasoline Vapors

The gas phase above gasoline contains a high percentage of highly volatile hydrocarbon compounds. The quantity and composition of gasoline vapors are dependent on such parameters as the temperature and pressure of the containing system, the composition and Reid Vapor Pressure of the Gasoline, and the method of vapor generation. Table 5.3-1 presents example chemical compositions for the vapor phases in equilibrium with several motor gasolines.

5.4 Photochemical Reactivity of Gasoline Vapors

The primary goal in controlling hydrocarbon emissions from stationary and mobile sources is to reduce the production of photochemical smog from reactive hydrocarbons. Photochemical smog can cause eye and respiratory irritation, vegetation and materials damage, and it has an annoying odor.



S = SLOPE OF THE astm DISTILLATION CURVE AT 10% EVAPORATED =

$$\frac{\text{°F AT 15\% MINUS °F AT 5\%}}{10}$$

IN THE ABSENCE OF DISTILLATION DATA THE FOLLOWING AVERAGE VALUE OF S MAY BE USED:

MOTOR GASOLINE	3
AVIATION GASOLINE	2
LIGHT NAPHTHA (9 TO 14 lb rvp)	3.5
NAPHTHA (2 TO 8 lb rvp)	2.5

FIGURE 5.2-1 - VAPOR PRESSURES OF GASOLINES AND FINISHED PETROLEUM PRODUCTS, 1 lb to 20 lb RVP. NOMOGRAPH DRAWN FROM DATA OF THE NATIONAL BUREAU OF STANDARDS (AMERICAN PETROLEUM INSTITUTE, 1962b). (DA-004)

TABLE 5.2-1

MOTOR GASOLINE SURVEY, SUMMER 1973 AVERAGE DATA FOR BRANDS IN EACH DISTRICT

PREMIUM-PRICE GASOLINE

DISTRICT NO. AND NAME		NO. OF BRANDS	SAMPLES	GR., ASTM D287 API	SULF, ASTM D1266 WT %	GUM, ASTM D381 MG	PHOS. ASTM D3231 G/GAL	LEAD, ASTM D526 G/GAL	OCTANE NUMBER			RVP, ASTM D323 LB	20V/L ASTM D439 F	DISTILLATION, ASTM D86											
									RES, ASTM D2699	MOT, ASTM D2700	R+M --- 2			TEMPERATURE, F (CORRECTED TO 760 MM HG)										RES %	LOSS %
														IBP	PERCENT EVAPORATED 5	10	20	30	50	70	90	95	EP		
1	NORTHEAST	13	58	60.0	0.030	0	-	2.39	99.8	91.8	95.8	10.1	133	89	100	115	139	166	219	261	327	363	402	1.2	1.9
2	MID-ATLANTIC COAST	17	214	59.5	.024	1	0.014	2.43	99.6	91.7	95.7	9.8	135	90	105	119	142	168	219	264	330	365	408	1.1	1.7
3	SOUTHEAST	18	198	60.2	.026	0	-	2.51	99.8	92.0	95.9	9.5	136	92	106	119	143	169	218	263	328	362	405	1.0	1.6
4	APPALACHIAN	17	166	61.4	.019	1	.003	2.27	99.5	91.9	95.7	10.3	132	89	103	117	141	167	215	258	328	364	411	1.0	2.2
5	MICHIGAN	15	106	63.2	.024	1	.004	2.31	99.4	92.1	95.8	10.2	132	90	104	119	143	171	210	250	319	356	404	.9	1.9
6	NORTH ILLINOIS	14	61	63.3	.028	1	.001	2.30	99.4	92.5	96.0	10.2	132	90	103	118	144	170	210	244	320	363	407	.9	1.9
7	CENTRAL MISSISSIPPI	21	109	62.8	.021	1	.003	2.35	99.5	92.1	95.8	9.4	137	90	107	120	147	172	212	249	321	362	404	.9	1.8
8	LOWER MISSISSIPPI	19	147	60.5	.034	0	.000	2.59	99.6	91.9	95.8	9.2	138	89	108	122	146	171	217	260	331	363	410	1.0	1.6
9	NORTH PLAINS	14	52	65.1	.040	0	-	2.52	99.0	93.3	96.2	9.5	136	89	106	121	149	174	209	239	314	358	399	1.1	1.6
10	CENTRAL PLAINS	12	93	65.0	.035	1	-	2.23	98.9	91.9	95.4	8.8	139	92	110	124	147	169	211	245	320	365	410	1.0	1.6
11	SOUTH PLAINS	20	133	63.3	.024	1	.000	2.69	99.2	92.5	95.9	9.0	139	91	108	123	148	172	215	252	327	365	409	1.0	1.6
12	SOUTH TEXAS	15	94	60.8	.019	1	.004	2.65	99.6	92.0	95.8	9.0	135	91	108	122	144	167	215	258	329	358	400	1.0	1.3
13	SOUTH MOUNTAIN STATES	16	243	61.9	.025	1	.000	2.47	98.1	91.0	94.6	8.7	142	94	113	128	150	173	218	260	336	375	414	.9	1.3
14	NORTH MOUNTAIN STATES	13	137	64.1	.034	1	.005	2.24	99.0	91.8	95.4	9.6	136	87	107	121	147	173	213	247	324	362	404	.9	2.0
15	PACIFIC NORTHWEST	9	59	61.8	.008	1	.001	2.35	99.1	91.7	95.4	10.2	132	88	104	118	141	164	212	255	313	341	383	1.0	2.0
16	NORTH CALIFORNIA	11	70	57.4	.011	1	.001	2.07	99.3	91.6	95.5	8.7	144	93	112	131	157	182	225	265	327	356	400	1.0	1.7
17	SOUTH CALIFORNIA	11	91	58.2	.034	1	.001	2.65	99.1	91.2	95.2	9.0	141	92	110	126	150	173	219	263	327	360	409	1.0	1.6
	AVERAGE			61.7	.026	1	.003	2.42	99.3	91.9	95.6	9.5	137	90	107	121	146	171	215	255	325	361	405	1.0	1.7

SAMPLES 2,031

REGULAR-PRICE GASOLINE

DISTRICT NO. AND NAME		NO. OF BRANDS	SAMPLES	GR., ASTM D287 API	SULF, ASTM D1266 WT %	GUM, ASTM D381 MG	PHOS. ASTM D3231 G/GAL	LEAD, ASTM D526 G/GAL	OCTANE NUMBER			RVP, ASTM D323 LB	20V/L ASTM D439 F	DISTILLATION, ASTM D86											
									RES, ASTM D2699	MOT, ASTM D2700	R+M --- 2			TEMPERATURE, F (CORRECTED TO 760 MM HG)										RES %	LOSS %
														IBP	PERCENT EVAPORATED 5	10	20	30	50	70	90	95	EP		
1	NORTHEAST	12	52	60.7	0.040	0	-	2.21	94.2	87.0	90.6	9.8	132	88	102	115	136	158	209	267	340	372	410	1.0	2.0
2	MID-ATLANTIC COAST	17	209	60.1	.037	1	0.007	2.16	94.1	86.7	90.4	9.7	134	91	107	119	140	161	211	270	347	384	420	1.1	1.6
3	SOUTHEAST	18	200	60.2	.037	0	-	2.33	94.1	86.9	90.5	9.3	136	92	108	121	142	163	213	273	350	383	420	1.0	1.5
4	APPALACHIAN	17	171	60.6	.037	1	.015	2.12	93.9	86.3	90.1	9.9	133	89	105	118	139	161	209	265	342	381	422	1.1	1.5
5	MICHIGAN	13	158	59.7	.047	2	.007	1.85	94.1	86.2	90.2	10.1	133	89	104	118	140	163	213	267	344	379	421	.9	1.5
6	NORTH ILLINOIS	14	64	59.6	.048	2	.001	1.91	94.1	86.3	90.2	9.9	133	92	105	118	140	163	212	264	343	382	424	1.0	1.8
7	CENTRAL MISSISSIPPI	20	107	59.7	.039	1	.003	1.86	93.9	86.3	90.1	9.5	136	89	106	119	142	167	217	271	349	386	421	.9	1.8
8	LOWER MISSISSIPPI	19	121	60.7	.044	0	-	2.54	93.9	86.8	90.4	9.0	137	91	110	122	142	163	209	265	347	378	420	1.0	1.4
9	NORTH PLAINS	12	45	60.8	.050	0	-	2.06	92.7	85.2	89.0	9.5	132	90	104	116	136	156	202	255	335	374	418	1.0	1.5
10	CENTRAL PLAINS	12	83	61.7	.045	1	-	1.83	92.6	85.3	89.0	8.7	139	95	111	123	143	163	208	259	338	382	417	1.0	1.4
11	SOUTH PLAINS	20	135	61.4	.033	1	.000	2.31	93.0	86.3	89.7	8.9	138	92	109	121	142	162	209	262	340	381	417	1.0	1.7
12	SOUTH TEXAS	15	88	60.8	.032	1	.004	2.35	93.8	86.6	90.2	8.9	138	93	110	124	143	162	207	262	338	373	409	1.0	1.5
13	SOUTH MOUNTAIN STATES	16	232	60.2	.042	2	.000	1.92	92.4	85.2	88.8	8.5	142	98	115	129	149	169	213	265	345	382	417	.9	1.3
14	NORTH MOUNTAIN STATES	13	129	60.9	.050	1	.004	1.78	93.3	85.3	89.3	9.5	135	88	106	119	141	163	210	262	340	376	416	.9	1.9
15	PACIFIC NORTHWEST	9	59	61.1	.017	2	.000	2.08	93.0	86.6	89.8	10.1	133	90	106	119	142	165	211	260	337	370	409	1.0	1.9
16	NORTH CALIFORNIA	11	72	56.7	.033	1	.001	1.53	93.6	85.2	89.4	8.7	141	95	112	127	148	170	216	268	339	368	409	1.0	1.6
17	SOUTH CALIFORNIA	11	92	58.5	.036	1	.001	1.40	93.3	85.2	89.3	8.9	139	93	110	124	144	166	212	270	342	372	412	1.0	1.5
	AVERAGE			60.3	.040	1	.004	2.01	93.5	86.1	89.8	9.3	136	91	108	121	142	163	211	265	342	378	417	1.0	1.6

SAMPLES 2,017

TABLE 5.2-2

MOTOR GASOLINE SURVEY, WINTER 1971-72 AVERAGE DATA FOR BRANDS IN EACH DISTRICT

PREMIUM-PRICE GASOLINE

DISTRICT NO. AND NAME		NO. OF BRANDS	SAMPLES	GR., ASTM D287 API	SULF., ASTM D1266 WT %	GUM, ASTM D381 MG	LEAD, ASTM D526 G/GAL	OCTANE NUMBER			RVP, ASTM D323 LB	DISTILLATION, ASTM D86												
								RES., ASTM D2699	MOT., ASTM D2700	R+M --- 2		TEMPERATURE, F (CORRECTED TO 760 MM HG)											RES %	LOSS %
												IBP	PERCENT EVAPORATED								EP		
													5	10	20	30	50	70	90	95			
1	NORTHEAST	15	82	61.5	0.021	1	2.46	100.3	92.1	96.2	12.7	80	90	104	124	149	206	257	319	348	390	1.0	2.9
2	MID-ATLANTIC COAST	19	267	61.5	.024	1	2.37	100.4	92.4	96.4	13.0	80	91	103	125	151	209	257	323	351	394	.9	2.9
3	SOUTHEAST	20	203	61.5	.016	1	2.56	100.2	92.4	96.3	11.6	83	97	107	130	155	207	254	325	353	397	1.1	2.2
4	APPALACHIAN	20	186	63.1	.021	1	2.20	100.1	92.8	96.5	12.9	82	93	104	126	154	207	252	319	351	395	.9	3.2
5	MICHIGAN	17	108	63.8	.017	1	2.27	99.8	92.6	96.2	12.8	81	91	104	128	156	210	250	320	355	400	.9	3.1
6	NORTH ILLINOIS	14	82	64.3	.026	1	2.29	99.6	92.8	96.2	12.7	82	91	107	130	155	210	250	323	354	400	.8	2.9
7	CENTRAL MISSISSIPPI	21	130	62.1	.024	-	2.59	99.9	92.6	96.3	12.5	81	92	108	132	159	216	259	327	358	401	.9	2.4
8	LOWER MISSISSIPPI	20	135	62.8	.029	1	2.60	100.1	92.3	96.2	12.0	86	99	110	132	159	208	251	322	355	400	1.1	1.9
9	NORTH PLAINS	15	51	67.7	.041	-	2.38	99.1	92.7	95.9	12.0	82	97	113	139	166	209	243	318	344	396	.7	2.0
10	CENTRAL PLAINS	21	155	64.0	.032	1	2.30	99.6	92.3	96.0	11.4	83	97	112	135	160	210	250	320	354	403	.9	1.7
11	SOUTH PLAINS	20	140	63.9	.028	1	2.58	99.6	92.9	96.3	11.9	85	99	112	136	163	213	255	328	363	408	1.0	1.6
12	SOUTH TEXAS	16	89	62.0	.015	1	2.58	100.0	92.3	96.2	11.4	84	98	109	131	153	203	250	316	345	391	1.0	1.9
13	SOUTH MOUNTAIN STATES	16	263	63.1	.027	2	2.43	98.4	91.3	94.9	11.3	86	99	113	137	162	212	256	329	364	405	1.0	1.7
14	NORTH MOUNTAIN STATES	14	112	66.3	.047	1	2.24	99.7	91.7	95.7	12.9	84	95	108	134	162	210	244	318	356	398	.9	3.3
15	PACIFIC NORTHWEST	10	61	64.0	.012	1	2.14	99.9	92.0	96.0	12.0	85	96	108	128	152	202	246	308	338	383	1.0	2.3
16	NORTH CALIFORNIA	11	70	59.6	.016	1	2.52	99.9	92.0	96.0	11.4	87	96	111	136	162	211	257	322	349	396	.9	2.6
17	SOUTH CALIFORNIA	11	94	58.4	.041	1	2.75	100.0	91.6	95.9	10.7	88	102	117	141	167	218	263	325	356	405	1.0	2.1
	AVERAGE			62.9	.026	1	2.43	99.8	92.3	96.1	12.1	83	95	109	132	158	209	253	321	353	398	.9	2.4

SAMPLES 2,228

REGULAR-PRICE GASOLINE

DISTRICT NO. AND NAME		NO. OF BRANDS	SAMPLES	GR., ASTM D287 API	SULF., ASTM D1266 WT %	GUM, ASTM D381 MG	LEAD, ASTM D526 G/GAL	OCTANE NUMBER			RVP, ASTM D323 LB	DISTILLATION, ASTM D86												
								RES., ASTM D2699	MOT., ASTM D2700	R+M --- 2		TEMPERATURE, F (CORRECTED TO 760 MM HG)											RES %	LOSS %
												IBP	PERCENT EVAPORATED								EP		
													5	10	20	30	50	70	90	95			
1	NORTHEAST	15	75	63.1	0.039	1	1.89	95.2	87.5	91.4	12.6	80	93	104	124	146	196	257	336	367	401	1.0	2.5
2	MID-ATLANTIC COAST	21	277	62.3	.039	1	1.89	94.9	87.1	91.0	12.6	81	92	104	125	148	199	260	340	370	408	1.0	2.7
3	SOUTHEAST	19	203	62.1	.043	1	2.16	94.6	86.9	90.8	11.4	83	98	109	129	151	199	255	337	369	405	1.1	1.9
4	APPALACHIAN	24	190	62.6	.034	1	1.90	94.8	87.1	91.0	12.9	82	93	103	124	146	196	256	337	370	411	1.0	2.8
5	MICHIGAN	17	115	62.8	.033	1	1.72	94.8	86.7	90.8	13.0	81	90	101	122	146	199	257	337	370	410	.9	2.9
6	NORTH ILLINOIS	14	81	63.3	.056	2	1.83	94.4	86.9	90.7	13.1	83	91	104	123	145	196	256	335	367	406	.9	2.5
7	CENTRAL MISSISSIPPI	20	126	62.9	.036	-	2.01	94.4	86.9	90.7	12.6	82	92	106	126	147	199	257	343	376	414	.9	2.1
8	LOWER MISSISSIPPI	19	131	63.0	.039	1	2.13	94.3	86.7	90.5	12.1	84	98	109	127	149	195	252	336	369	410	1.1	1.7
9	NORTH PLAINS	13	45	63.3	.066	-	1.49	92.4	84.5	88.5	12.2	81	95	108	129	152	201	260	345	367	414	.9	1.5
10	CENTRAL PLAINS	21	147	63.1	.045	1	1.93	93.4	86.4	89.9	11.5	84	99	111	131	152	199	254	332	366	406	.9	1.6
11	SOUTH PLAINS	20	134	63.6	.041	1	2.17	93.3	86.5	89.9	11.9	85	96	110	129	150	200	256	338	374	413	1.1	1.6
12	SOUTH TEXAS	16	84	63.6	.027	2	2.40	94.4	87.0	90.7	11.1	87	99	111	130	150	195	248	325	356	398	1.2	1.5
13	SOUTH MOUNTAIN STATES	16	255	63.0	.043	2	1.82	92.3	85.6	89.0	11.2	87	100	113	134	155	201	254	338	374	414	1.0	1.8
14	NORTH MOUNTAIN STATES	14	137	62.7	.062	2	1.38	93.8	86.2	90.0	12.9	84	95	106	126	150	199	254	333	371	404	1.0	2.7
15	PACIFIC NORTHWEST	10	61	63.9	.024	1	2.03	93.4	87.1	90.3	12.3	82	95	106	125	148	196	247	334	373	408	1.0	2.2
16	NORTH CALIFORNIA	11	71	61.2	.031	1	1.77	93.9	86.0	90.0	11.1	87	99	113	135	157	204	256	327	358	401	.9	2.2
17	SOUTH CALIFORNIA	11	92	60.1	.095	1	1.50	93.8	85.5	89.7	10.9	88	101	116	137	159	204	263	342	373	411	1.0	2.2
	AVERAGE			62.7	.044	1	1.88	94.0	86.5	90.3	12.1	84	96	108	128	150	199	255	336	369	408	1.0	2.1

SAMPLES 2,224

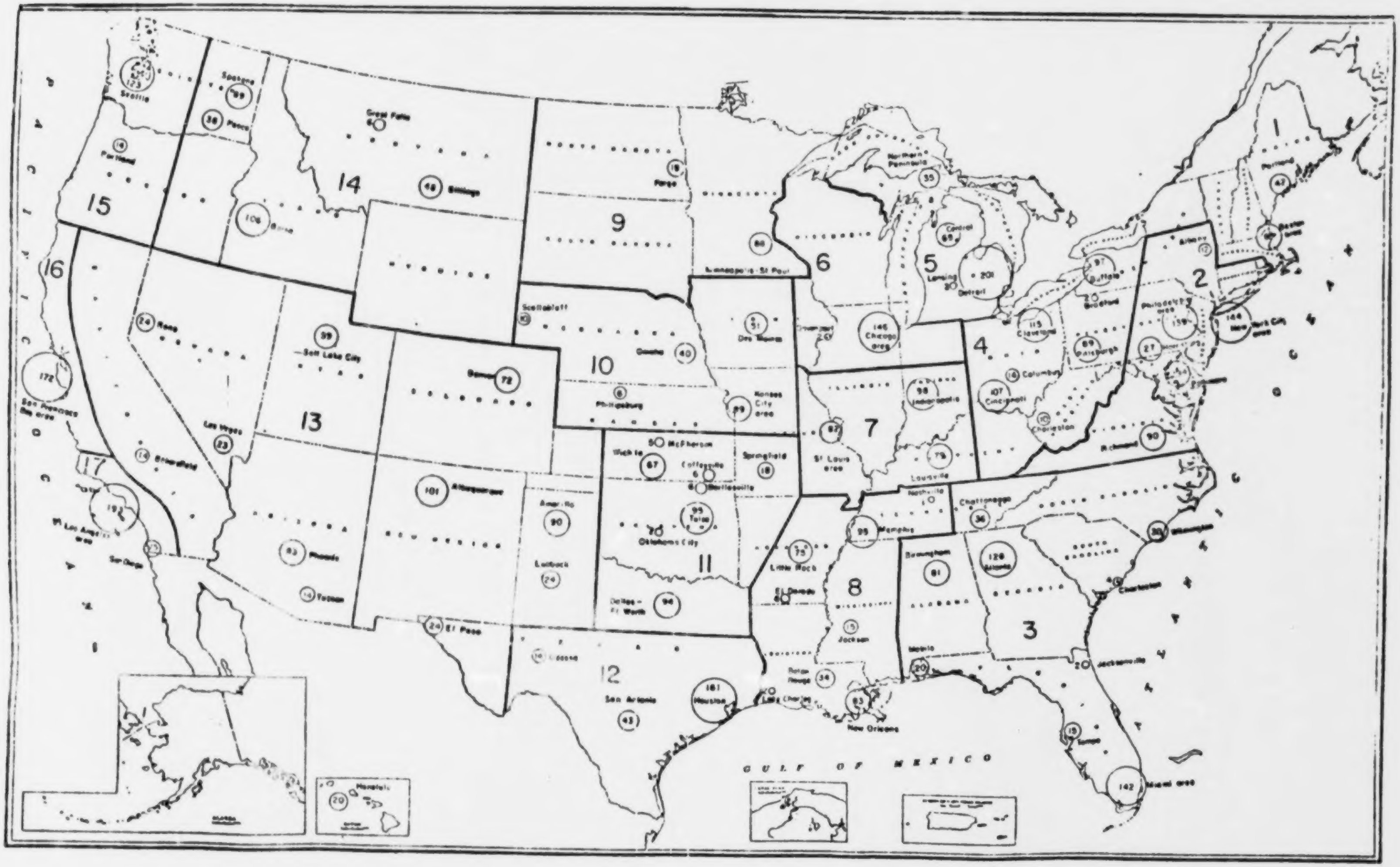

PACIFIC OCEAN
GULF OF MEXICO
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
123 Seattle
99 Spokane
38 Pasco
14 Portland
Great Falls 8
48 Billings
106 Boise
172 San Francisco Bay area
24 Reno
39 Salt Lake City
23 Las Vegas
14 Bakersfield
192 Los Angeles area
San Diego
Denver 72
101 Albuquerque
83 Phoenix
14 Tucson
24 El Paso
Amarillo 90
Lubbock 24
Laredo
San Antonio 43
161 Houston
Lake Charles
Baton Rouge 34
83 New Orleans
Fargo 18
88 Minneapolis-St Paul
Scottsbluff
Omaha 40
6 Philipsburg
31 Des Moines
89 Kansas City area
8 McPherson
Wichita 67
Coffeyville 6
6 Bartlesville
Springfield 18
95 Tulsa
70 Oklahoma City
Dallas-Ft Worth 94
Northern Peninsula 35
Central 65
Lansing 30
201 Detroit
146 Chicago area
Davenport 20
87 St Louis area
98 Indianapolis
79 Louisville
Nashville 10
95 Memphis
75 Little Rock
El Dorado 8
15 Jackson
Birmingham 81
Mobile 20
128 Atlanta
Chattanooga 36
115 Cleveland
14 Columbus
107 Cincinnati
10 Charleston
97 Buffalo
20 Bradford
89 Pittsburgh
Albany 12
Philadelphia area 159
27
144 New York City area
Boston area
Portland 42
Richmond 90
30 Wilmington
Charleston
20 Jacksonville
15 Tampa
142 Miami area
Honolulu 20
ALASKA

FIGURE 5.2-2 - MAP SHOWING LOCATIONS AND NUMBERS OF SAMPLES FOR THE NATIONAL MOTOR GASOLINE SURVEY, SUMMER 1973

INT.-BU.OF MINES,PGH.,PA. 19184

TABLE 5.3-1

EXAMPLE GASOLINE VAPOR COMPOSITIONS

Month	Feb.	Oct.	May	May	-	Summer
Location	Las Vegas	-	-	-	-	-
Ambient Temp	45°F	-	-	-	-	-
Compound	Volume %					
air	78.4	70.9	67.5	87.7	58.1	58.4
methane	0.3	0.0	0.4	0.0	-	-
ethylene	0.0	0.1	0.0	0.0	-	0.8
ethane	0.0	0.0	0.0	0.0	-	
propane	0.4	0.5	1.9	0.1	0.6	1.3
isobutane	3.1	1.8	7.8	0.2	2.9	18.8
butene	-	-	-	-	3.2	
n-butane	10.2	9.6	10.9	2.6	17.4	
isopentane	4.3	10.8	5.4	5.1	7.7	13.6
pentene	-	-	-	-	5.1	
n-pentane	1.8	1.1	3.9	1.1	2.0	
hexane	1.0	2.9	1.4	1.6	3.0	7.1
heptane and higher	0.4	2.2	0.7	1.2		
Reference	WE-111	WE-111	WE-111	WE-111	DA-069	SC-186

Chemical Reactions

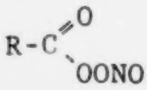
Reactive hydrocarbons and nitrogen oxides react in the presence of ultraviolet light and under suitable meteorological conditions to form photochemical oxidants which cause the major effects associated with photochemical smog. All hydrocarbons are reactive to some degree with olefins, aromatics, and aldehydes being the most reactive. The photochemical oxidant products are primarily ozone (O_3), nitrogen dioxide (NO_2), peroxyacylnitrates (PAN), and oxygenated organics. The photochemical reaction is complex and still under research, but can be simplified to the following major reactions (PI-040).

$$NO_2 \overset{uv}{\rightleftarrows} NO + O$$

$$O + NO_2 \rightarrow NO_3$$

$$O + O_2 \rightarrow O_3$$

$$\text{reactive hydrocarbons} + O_3 \rightarrow \text{aldehydes} + \text{oxygenated hydrocarbons}$$



$$\text{reactive hydrocarbons} + NO_3 \rightarrow R\text{-}C\begin{array}{l} /\!\!/ O \\ \setminus OONO_2 \end{array}$$

The rate of photochemical oxidant production is dependent on hydrocarbon reactivity, ambient temperature, and ultraviolet light intensity and exposure.

Relative Reactivity

The relative reactivity of the hydrocarbons contained in gasoline vapors is important in assessing the merits of controlling gasoline vapor emissions. Relative reactivity is the tendency of hydrocarbons to undergo chemical reactions leading to the formation of photochemical oxidants, and accounts for the reaction rate and the severity of reaction product effects on plants and animals. Table 5.4-1 (MS-001) lists the relative reactivity of several hydrocarbons contained in gasoline vapors. The high reactivity of gasoline vapor can be attributed to its high aromatic and olefinic content. The conversion to unleaded gasoline will further increase the reactivity of gasoline vapors due to the substitution of high octane aromatics for less reactive compounds. This increased reactivity of unleaded gasoline vapors is estimated to be 12% for premium grades and 28% for regular grades (MS-001).

5.5 Vapor-Liquid Equilibria

A very important property of gasoline to consider when studying gasoline vapor emissions is vapor-liquid equilibria. Figure 5.2-1 (DA-004) correlates the vapor pressure of gasoline vs. RVP and temperature. From this vapor pressure correlation Figure 5.5-1 (SC-167) was derived. It is used to estimate the quantity of hydrocarbons lost from displacement of saturated gasoline vapor. It can also be used to estimate the hydrocarbon emissions from a tank during refill, assuming vapor-liquid equilibrium has been reached in the tank.

However, it is often erroneous to assume that the vapor and liquid phases of an air-gasoline system are in equilibrium. Figure 5.5-2 and Figure 5.5-3 (AM-100) present the results of two tests by Chevron Research Company to define the composition gradient existing in the vapor space of service station gasoline storage tanks. The time duration between

TABLE 5.4-1

COMPARISON OF PRODUCT YIELDS AND EFFECTS CAUSED BY VARIOUS HYDROCARBONS

Substance or Sub-Class	Oxidant Formation	PAN Formation	Eye Irritation	Plant Damage	Averaged Response
C_1-C_5 paraffins	0	0	0	0	0
acetylene	0	0	0	0	0
benzene	0	0	0	0	0
C_6+ paraffins	0-4	0	0	0	1
toluene (and other monoalkyl-benzenes)	4	ND(a)	4	0-3	3
ethylene	6	0	5	+(b)	4
1-alkenes	6-10	4-6	4-8	6-8	7
diolefins	6-8	0-2	10	0	6
dialkyl and trialkyl-benzenes	6-10	5-10	4-8	5-10	6
internally double bonded olefins	5-10	8-10	4-8	10	8
aliphatic aldehydes	5-10	+(b)	+(b)	+(b)	-
gasoline	-	-	-	-	2.2

(a) No experimental data available

(b) Effect noted but data insufficient to quantitate

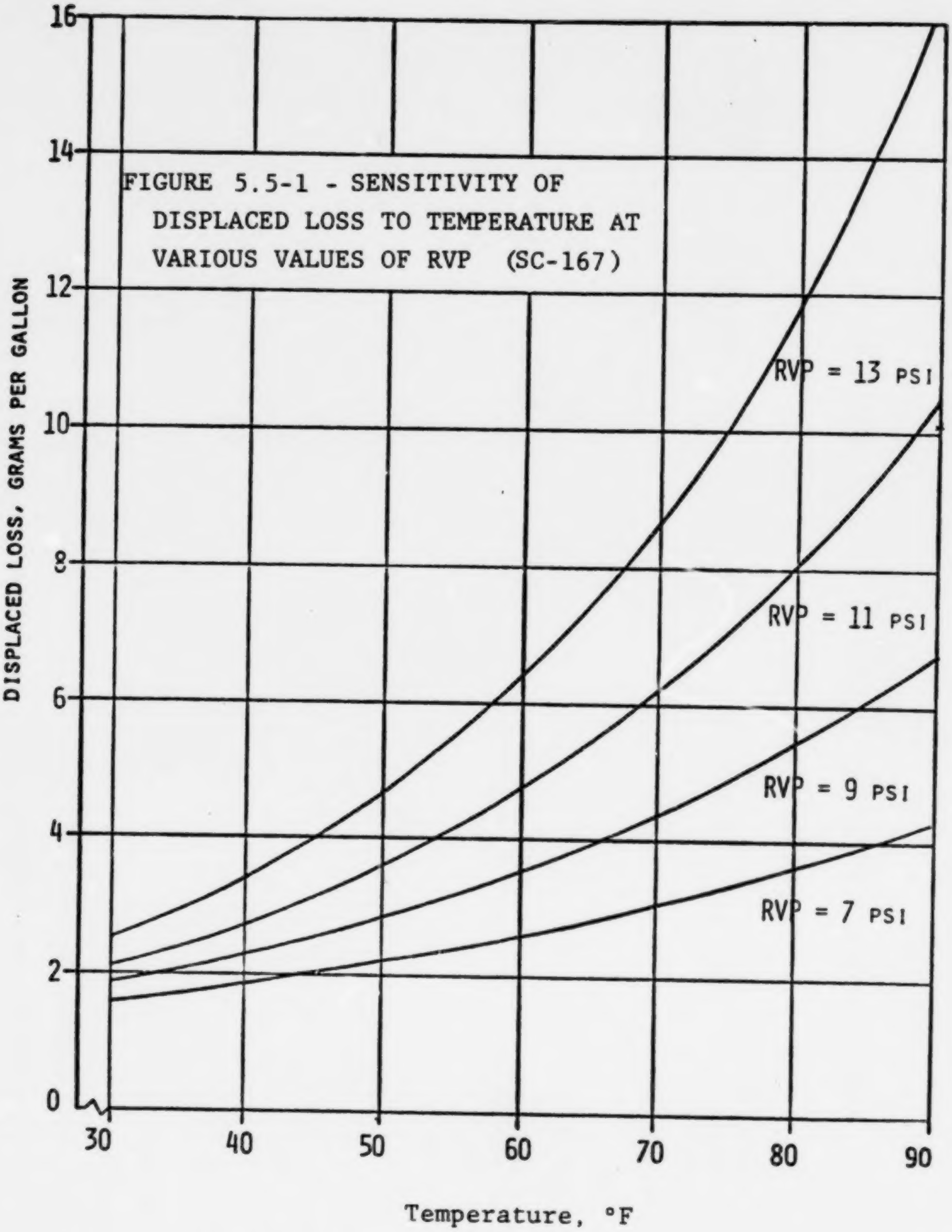


FIGURE 5.5-1 - SENSITIVITY OF DISPLACED LOSS TO TEMPERATURE AT VARIOUS VALUES OF RVP

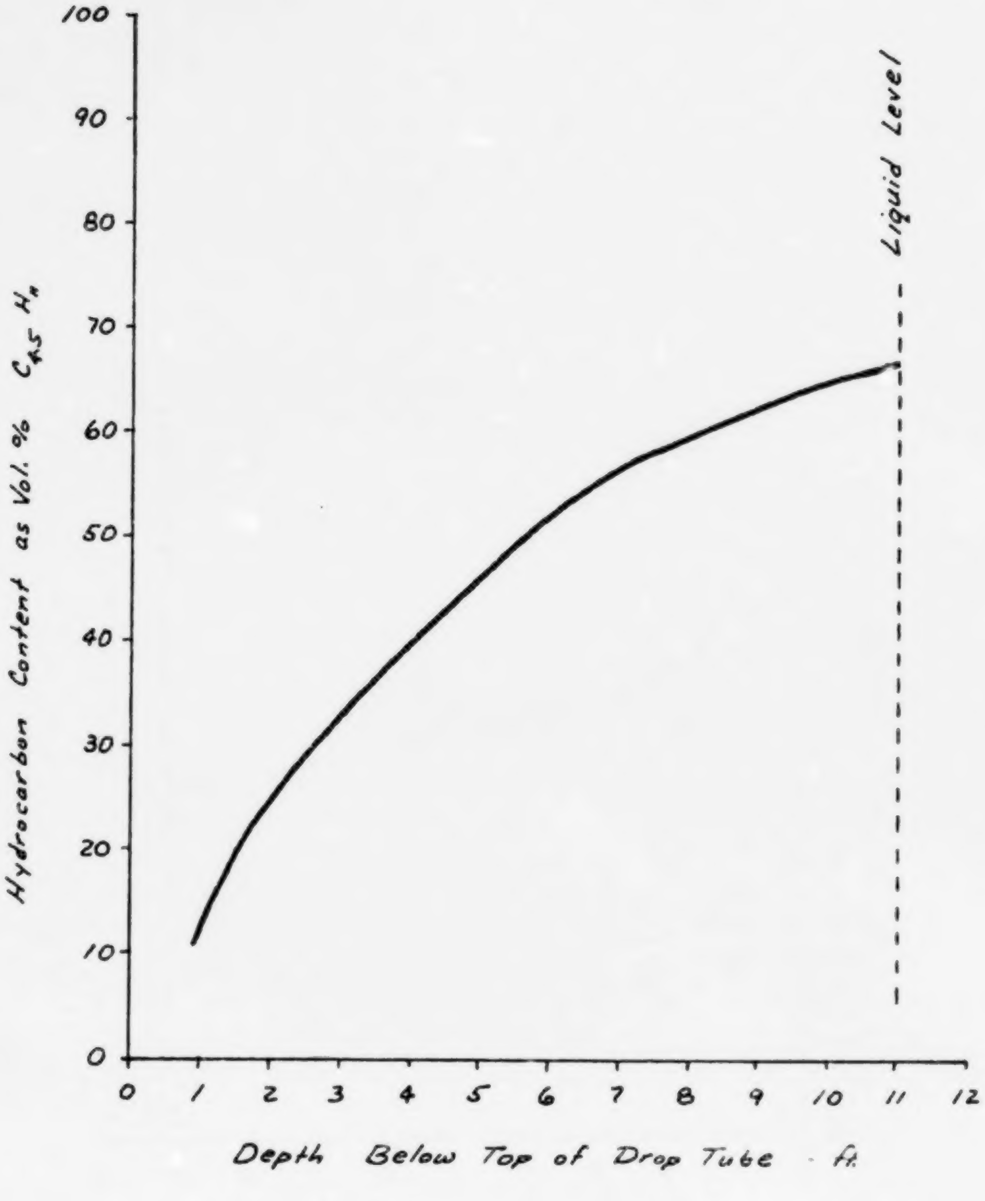


FIGURE 5.5-2 - HYDROCARBON PROFILE IN DROP TUBE (AM-100)

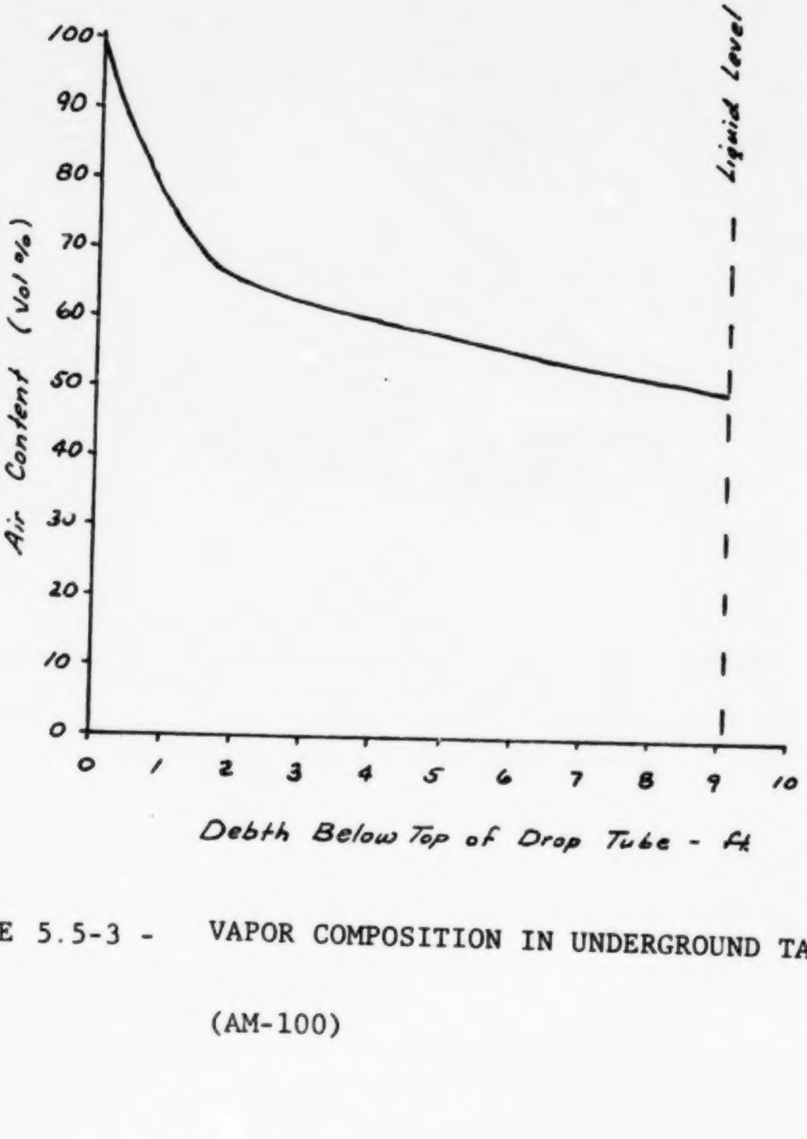


FIGURE 5.5-3 - VAPOR COMPOSITION IN UNDERGROUND TANK (AM-100)

the previous fuel delivery and the test was not noted but it was alluded to be several days. This concentration gradient indicates that only the vapor space adjacent to the vapor-liquid interface is saturated with hydrocarbons and that the hydrocarbon losses estimated by Figure 5.5-1 (MS-001) for displacement and tank breathing may be exceedingly high.

5.6 Solubility of Air in Gasoline

A number of recent vapor recovery studies indicate that when gasoline is transferred in the presence of air, the volume of vapor displaced is often less than would be theoretically predicted. A possible explanation for this vapor shrinkage is that the gasoline as it is dispensed absorbs a sufficient amount of air to account for the lost volume. Figure 5.6-1 predicts the solubility of air in octane based upon K values. Chevron Research Company performed tests which indicated that air free gasoline, when exposed to the atmosphere, "immediately" absorbed air to within 72% of the estimated equilibrium value (AM-100). These results indicate that the absorption of air by gasoline is a rapid reaction, and is in sufficient quantity to account for the vapor volume contraction often observed with balanced displacement vapor recovery systems.

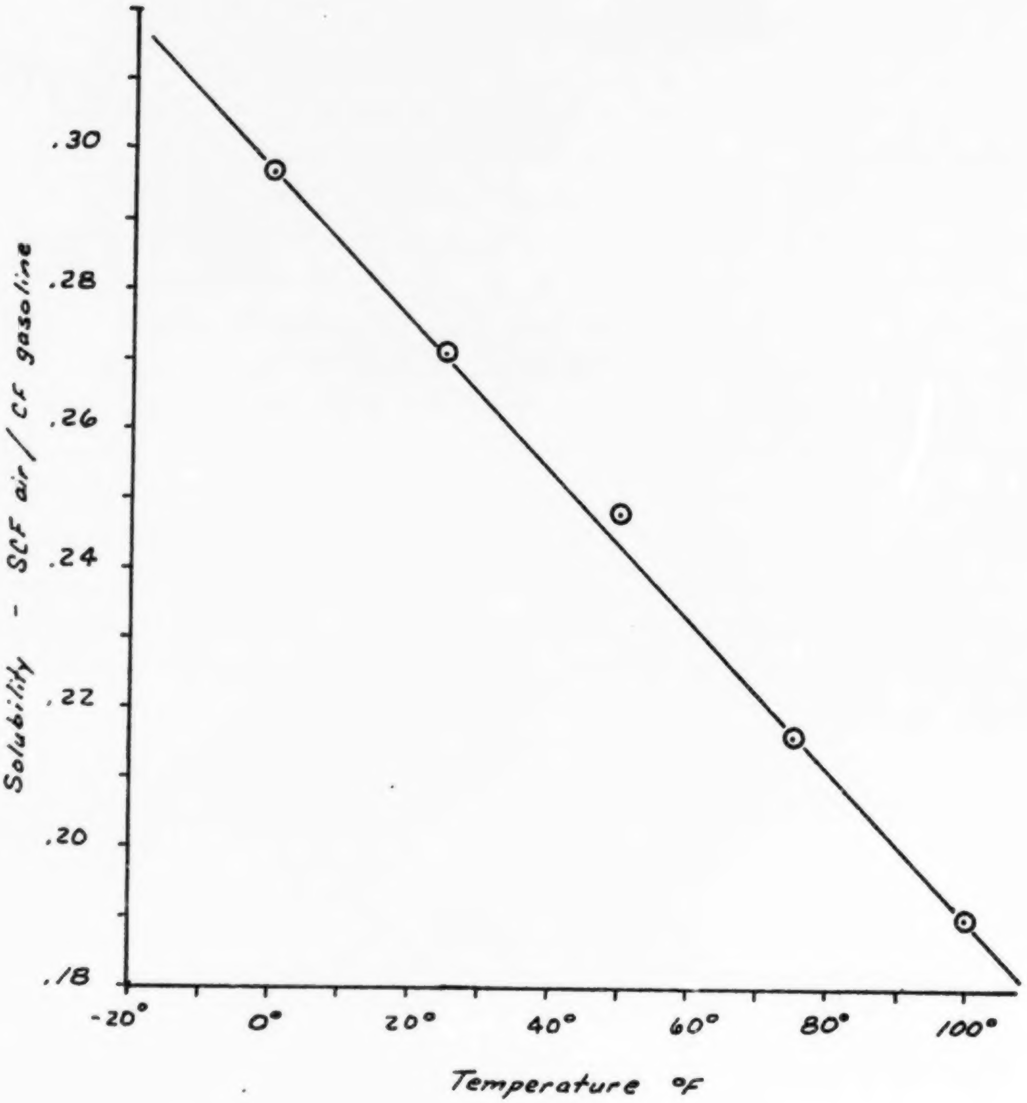


FIGURE 5.6-1 - SOLUBILITY OF AIR IN OCTANE

APPENDIX C

HYDROCARBON EMISSION FACTORS FOR GASOLINE MARKETING FACILITIES

1.0 INTRODUCTION

The following pages provide a survey of the methods available for the calculation of hydrocarbon emissions from various sources. Whenever possible, three different methods have been provided for each source: 1) a rough estimate employing emission factors, 2) a more precise value through the use of specific equations, and 3) a graphical solution utilizing nomographs.

2.0 DETERMINATION OF HYDROCARBON EMISSIONS

Various types of emissions occur during the marketing of gasoline. Standing storage emissions, caused by the capillary flow of liquid between the wall and seal, and withdrawal emissions, resulting when the roof moves downward exposing the wet walls to the air, occur in floating-roof tanks. Breathing losses and working emissions are commonly associated with fixed-roof tanks. Breathing losses occur when vapors expand with temperature increases. When the temperature decreases, the vapors contract and air enters the tank, causing further evaporation of liquid. Working losses include filling and emptying losses. As liquid is forced into a tank, vapors are displaced. As liquid is withdrawn, air enters and evaporation occurs.

2.1 Determination of Emissions from Floating-Roof Tanks

2.1.1 Standing Storage Emissions

The emission factor for standing storage losses from a "new" floating - roof tank is 0.033 lb/day-1000 gal, while the factor for "old" tank conditions is 0.088 lb/day-1000 gal.[3]

Fairly accurate values for standing storage emissions from a specific tank may be obtained by the equation[1]

$$L_s = F_T D^{1.5} \left(\frac{P}{14.7-P}\right)^{0.7} V_w^{0.7} K_s K_c F_p$$

where

L_s = standing storage emissions, bbl/yr.

F_T = tank factor based on type of roof, number and condition of seals, and construction defined as follows:

0.045 for welded tank with pan, double deck, or pontoon roof, single or double seal;
0.11 for riveted tank with pontoon or double deck roof, double seal;
0.13 for riveted tank with pan roof, double seal;
0.14 for riveted tank with pan roof, single seal.

D = tank diameter, ft. (If D is greater than 150, multiply the loss for D = 150 by factor of $\frac{\text{tank diameter}}{150}$).

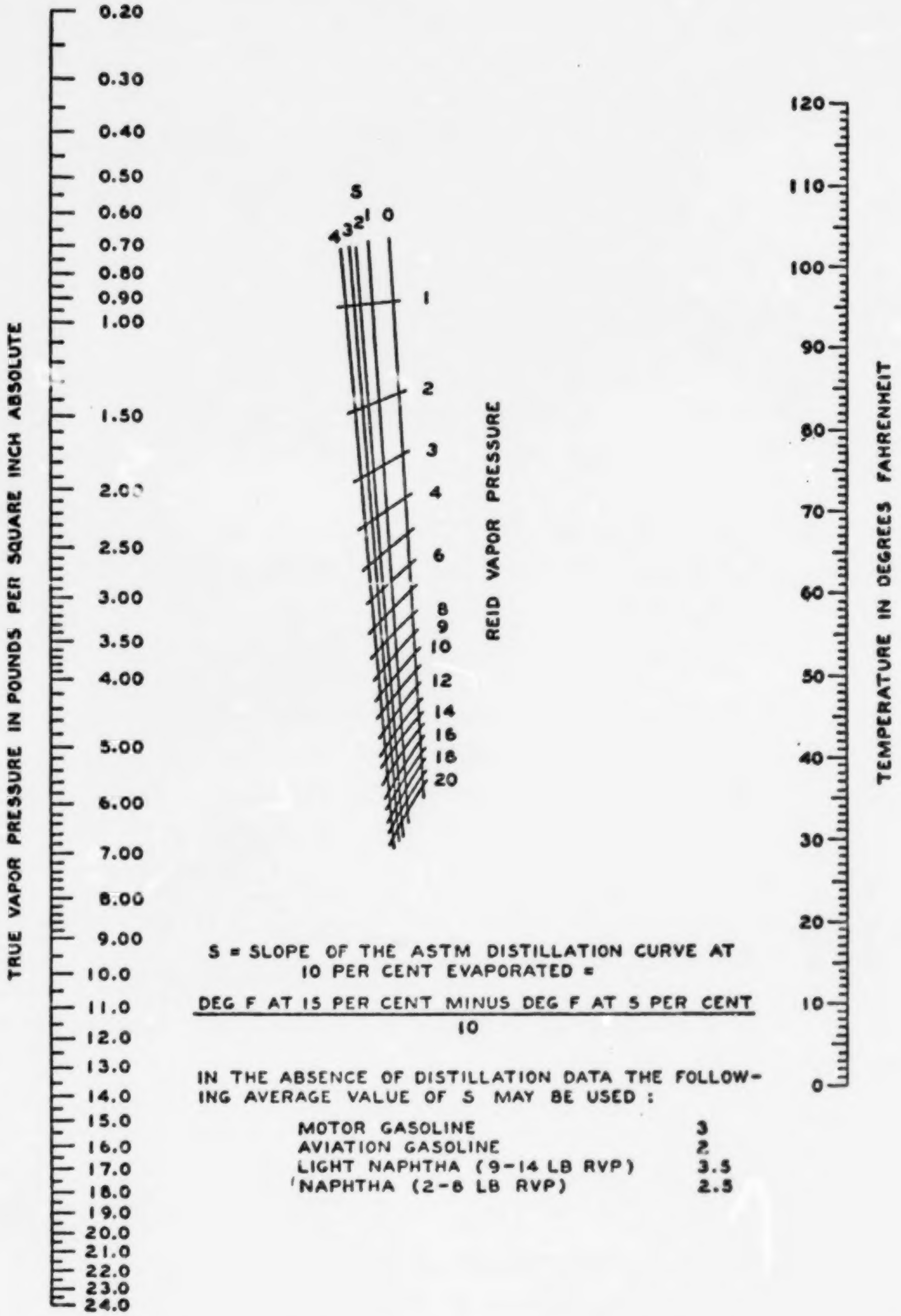
P = true vapor pressure of the blend at average storage temperature, psia. This vapor pressure can be obtained from Figure 2.1-1 if the Reid Vapor Pressure is known.[6]

V_w = average wind velocity, mph.

K_s = seal factor as follows:
1.00 for tight-fitting seal
1.33 for loose-fitting seal

K_c = stock factor = 1.00 for gasoline

F_p = paint factor for shell and roof:
1.00 for aluminum or light grey
0.90 for white



S = SLOPE OF THE ASTM DISTILLATION CURVE AT 10 PER CENT EVAPORATED =

$$\frac{\text{DEG F AT 15 PER CENT MINUS DEG F AT 5 PER CENT}}{10}$$

IN THE ABSENCE OF DISTILLATION DATA THE FOLLOWING AVERAGE VALUE OF S MAY BE USED :

MOTOR GASOLINE	3
AVIATION GASOLINE	2
LIGHT NAPHTHA (9-14 LB RVP)	3.5
NAPHTHA (2-8 LB RVP)	2.5

Source: Nomograph drawn from data of the National Bureau of Standards.

FIGURE 2.1-1 - VAPOR PRESSURES OF GASOLINES AND FINISHED PETROLEUM PRODUCTS

Expected accuracy of emissions determined by this equation for tanks with seals in good condition is ±25%. Actual emissions for tanks with seals in poor condition may exceed the estimated value by a factor of two or three.

A graphical solution for the standing storage emission factor can be found in Figure 2.1-2, and emissions can be determined through application of Table 2.1-1[6].

2.1.2 Withdrawal Emissions

Withdrawal emissions from floating-roof tanks may be calculated by the equation[1]

$$L_W = 22,400 \left(\frac{B}{D}\right)$$

where

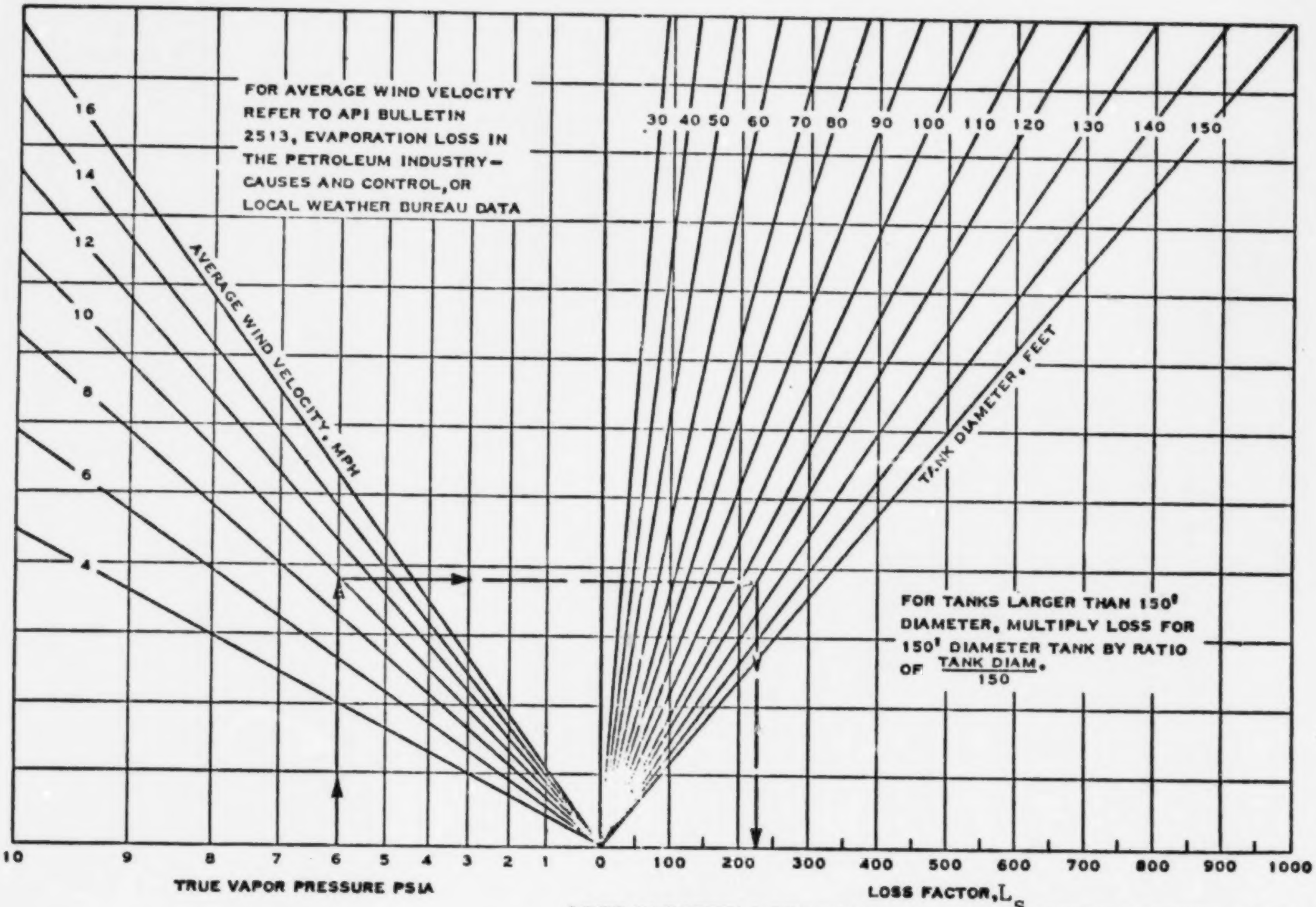
L_W = withdrawal emissions, bbl/million bbl throughput

B = 0.02 (based on barrels of clingage per 1000 ft^2 of shell surface) unless tank is gunite-lined, in which case 1.0 should be used. For gunited tanks, withdrawal emissions should be added to standing storage emissions to get total emissions.

D = tank diameter, ft.

An alternative equation[4] is

$$L_W^1 = 0.000448 \left(\frac{V}{D}\right)$$



LOSS IN BARRELS PER YEAR $= L_S$ X MULTIPLYING FACTOR (TABLE 1)

FIGURE 2.1-2 - LOSS FACTORS FOR FLOATING ROOF TANKS

TABLE 2.1-1

MULTIPLYING FACTORS FOR FLOATING ROOF TANKS

MULTIPLYING FACTORS TO APPLY TO L_S	WELDED TANKS				RIVETED TANKS															
	PAN OR PONTOON ROOF †				PAN ROOF								PONTOON ROOF †							
	SINGLE OR DOUBLE SEAL				SINGLE SEAL				DOUBLE SEAL				SINGLE SEAL				DOUBLE SEAL			
	MODERN		OLD*		MODERN		OLD*		MODERN		OLD*		MODERN		OLD*		MODERN		OLD*	
	TANK PAINT**		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT		TANK PAINT	
	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE	LT. GREY	WHITE
GASOLINE	1.0	.90	1.33	1.20	3.2	2.9	4.2	3.8	2.8	2.5	3.8	3.4	2.8	2.5	3.8	3.4	2.5	2.2	3.3	3.0

** Seals Installed prior to 1942 are classed as old seals*

*** Aluminum paint Is considered light gray in loss estimation*

† Double-Deck Floating Roof Considered Pontoon Roof

where

L_w^1 = withdrawal loss, bbl/yr.

V = volume of liquid withdrawn from tank, bbl/yr.

D = tank diameter, ft.

2.2 Determination of Emissions from Fixed-Roof Tanks

2.2.1 Breathing Losses

The accepted emission factor for breathing losses from fixed-roof tanks is 0.22 lb/day-1000 gal storage capacity for "new" tanks, 0.25 lb/day-1000 gal for "old" tanks.[3]

More accurate values for breathing emissions may be obtained from the following equation:[8]

$$L_B = \frac{24}{1000} \left(\frac{P}{14.7-P}\right)^{0.68} D^{1.73} H^{0.51} T^{0.50} F_P C$$

where

L_B = breathing emissions, bbl/yr.

P = true vapor pressure, psia, determined by Figure 2.1-1 at the average body temperature If the average temperature is unknown, 5°F above ambient temperature should be used.

D = tank diameter, ft.

H = equivalent outage in ft. (see Figure 2.2-1).[6]

T = average daily ambient temperature change, °F.

F_p^1 = paint factor (see Figure 2.2-3).[8]

C = an adjustment factor for tank size (see Figure 2.2-2).[8] For $D > 30$, use $C = 1$.

Alternatively, breathing emissions can be determined by use of the nomograph in Figure 2.2-3.[6]

2.2.2 Working Emissions

Working emissions for fixed-roof tanks may be estimated by use of the emission factor 9.0 lb/1000 gal throughput.[3]

More accurate values for working emissions from fixed-roof tanks may be obtained from the equation[8]

$$L_F = \left(\frac{3\ PV}{10,000}\right) K_t$$

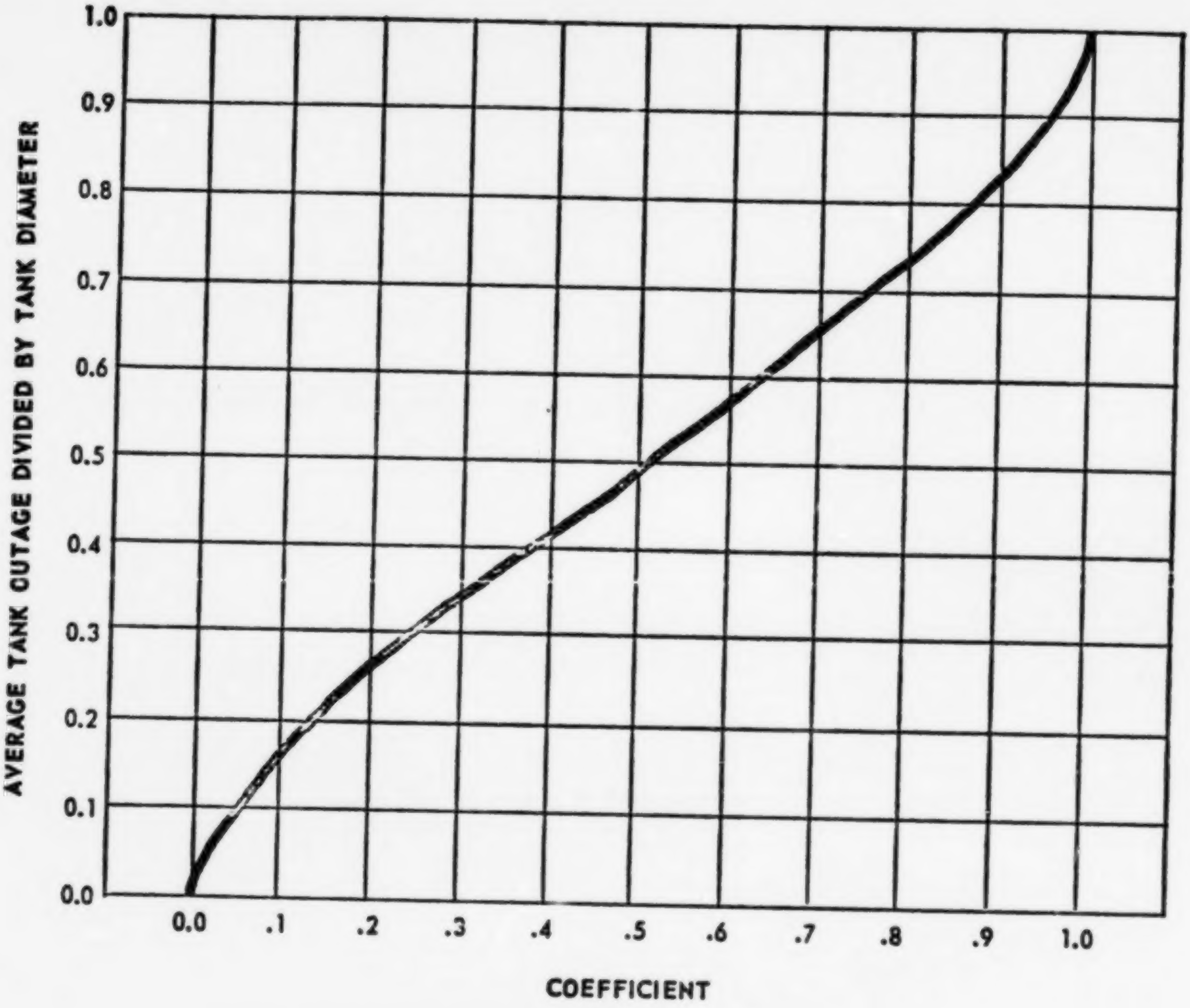
where

L_F = working loss, bbl.

P = true vapor pressure of the blend at average stock temperature, psia.

V^1= volume of liquid pumped into tank, bbl.

K_t = turnover factor (see Figure 2.2-4)[8].



TO FIND EQUIVALENT OUTAGE H FOR USE IN FIGURE 3, MULTIPLY LENGTH OF HORIZONTAL CYLINDRICAL TANK BY APPROPRIATE COEFFICIENT.

Example:

Horizontal Tank	
Diameter	10 Feet
Length	40 Feet
Average Outage	3 Feet
Outage/Diameter	0.3
Coefficient	0.25

Equivalent Outage H = 40 x 0.25 = 10 Feet

FIGURE 2.2-1 - EQUIVALENT OUTAGE H FOR HORIZONTAL CYLINDRICAL TANKS

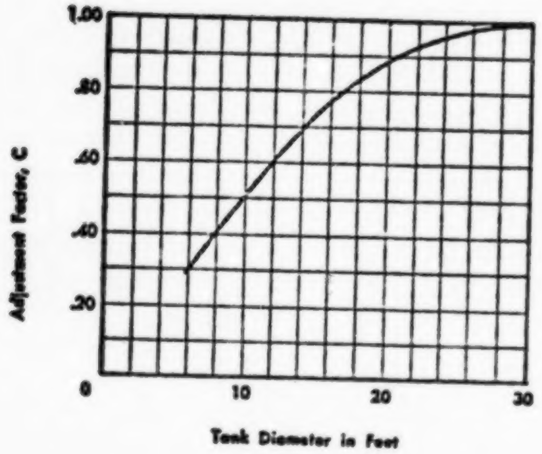


FIGURE 2.2-2 - ADJUSTMENT FACTOR FOR SMALL-DIAMETER TANKS

EXAMPLE:

T = 16°F

F_p' = 1.33

H = 23 Feet

P = 3.8 psia

D = 100 Feet

L_y = 1350 barrels per year

Tank Color		Paint Factor, F_p'	
Roof	Shell	Paint in Good Condition	Paint in Poor Condition
white	white	1.00	1.15
aluminum (specular)	white	1.04	1.18
white	aluminum (specular)	1.16	1.24
aluminum (specular)	aluminum (specular)	1.20	1.29
white	aluminum (diffuse)	1.30	1.38
aluminum (diffuse)	aluminum (diffuse)	1.39	1.46
white	gray	1.30	1.38
light gray	light gray	1.33	1.44
medium gray	medium gray	1.46	1.46

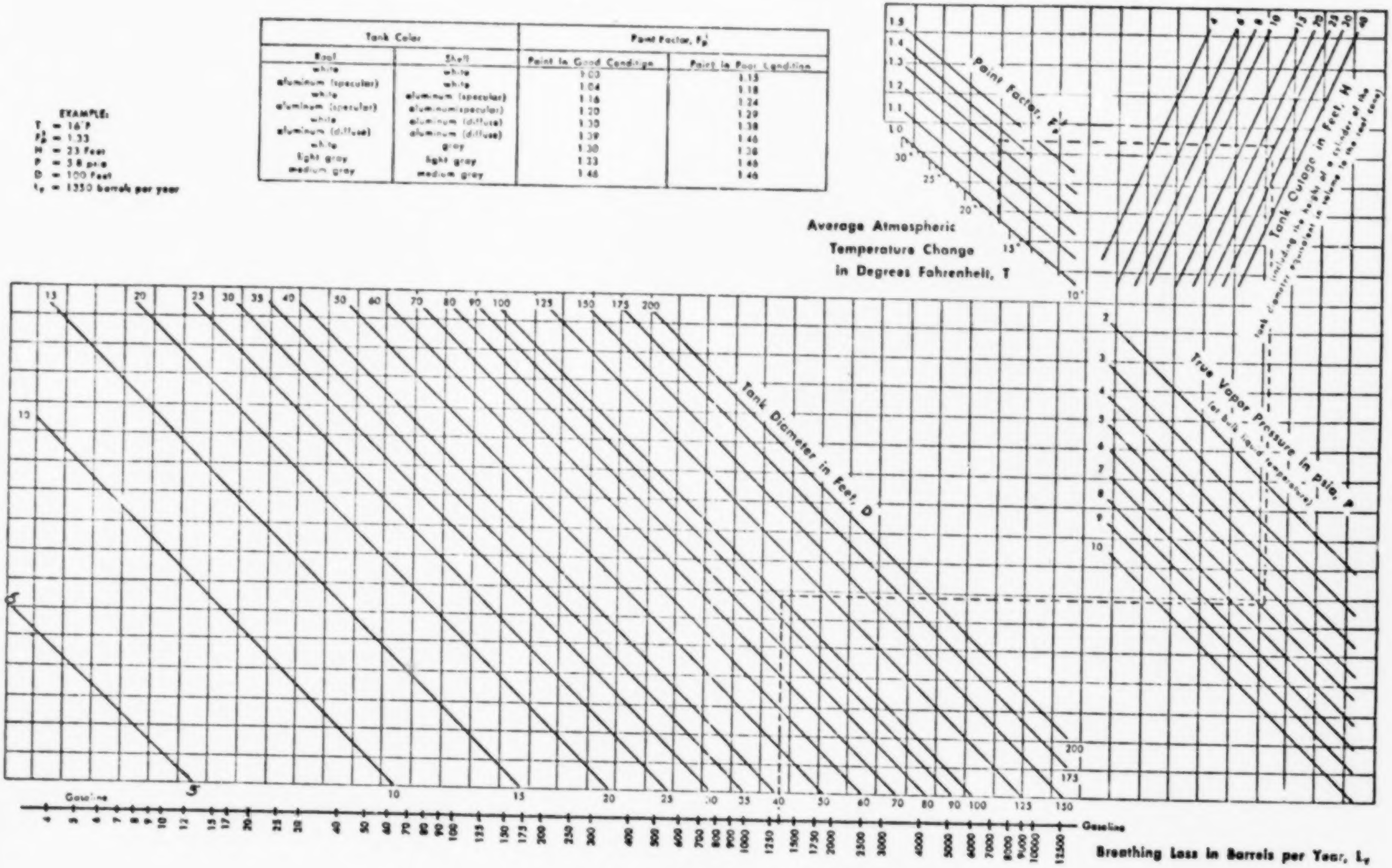


FIGURE 2.2-3 - BREATHING LOSS OF GASOLINE FROM FIXED-ROOF TANKS

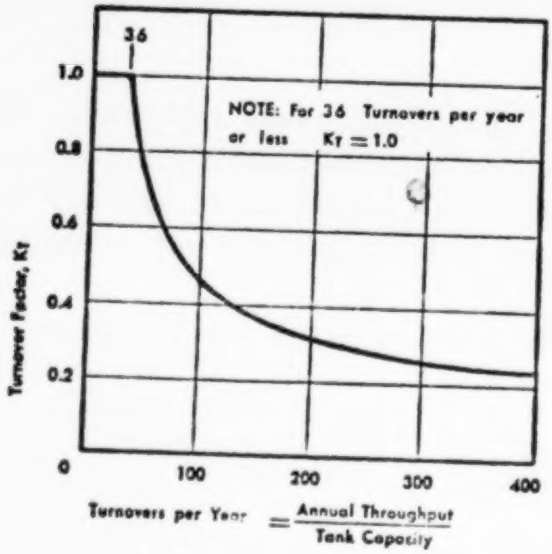


FIGURE 2.2-4 - EFFECT OF TURNOVER ON WORKING LOSS

In addition, working emissions may be found using Figure 2.2-5.[6]

2.3 Determination of Emissions from Variable Vapor-Space Tanks

Variable vapor-space tanks are useful in reducing breathing losses, especially when throughput is low. Working losses, however, are still significant, and may be estimated by an emission factor of 10.2 lb/1000 gal throughput.[3]

For a more precise value for emissions, the following formula[9] may be used:

$$L_F = \frac{3P}{10,000} (V_1 - 0.25 V_2 N)$$

where

L_F = filling loss, bbl.

P = true vapor pressure of the blend at average stock temperature, psia.

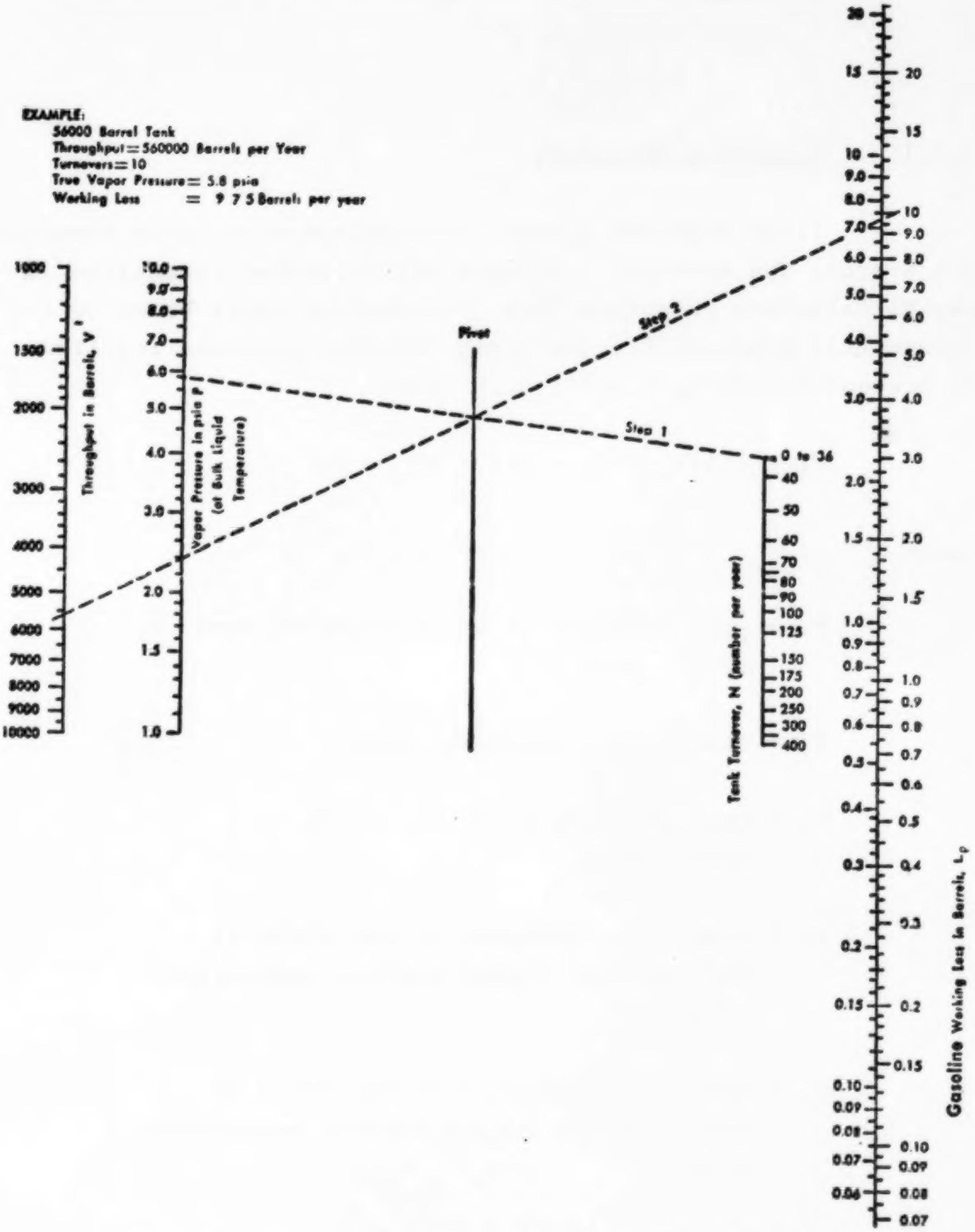
V_1 = volume of liquid pumped in, bbl.

V_2 = volume of expansion capacity, bbl.

N = number of transfers into system

2.4 Determination of Emissions from Low-Pressure Tanks

Low-pressure tanks may be used for the storage of motor gasoline. These tanks operate between pressures slightly above atmospheric pressure and 15 psig.



EXAMPLE:
56000 Barrel Tank
Throughput = 560000 Barrels per Year
Turnovers = 10
True Vapor Pressure = 5.8 psia
Working Loss = 9 7 5 Barrels per year

Note: The throughput is divided by a number (1, 10, 100, 1,000) to bring it into the range of the scale. The working loss, read from the scale, must then be multiplied by the same number.

FIGURE 2.2-5 - WORKING LOSS OF GASOLINE FROM FIXED-ROOF TANKS

2.4.1 Breathing Emissions

Since data for actual correlations with field conditions are scarce, the American Petroleum Institute has formulated[7] a way to calculate emissions from low-pressure tanks based on a theoretical pressure P_2, the design storage pressure required to prevent breathing losses, such that:

$$P_2 = 1.1(P_a + P_1 - p_1) - (P_a - p_2)$$

where

P_2 = gage pressure at which pressure vent opens, psig.

P_a = atmospheric pressure, psia.

P_1 = gage pressure at which vacuum vent opens, psig.

p_1 = true vapor pressure of the blend at 90°F minimum liquid surface temperature, psia.

p_2 = true vapor pressure of the blend at 100°F maximum liquid surface temperature, psia.

This equation is applicable only when p_1 is less than $(P_1 + P_a)$. When p_1 exceeds $(P_1 + P_a)$, air is kept out of the tank and the pressure required to prevent boiling is

$$P_2 = p_2 - P_a$$

For a plot of these equations, see Figure 2.4-1.[7] Corrections for altitude can be made using the appropriate atmospheric pressure (see Table 2.4-1.[7]

The relationship between low-pressure breathing emissions and tank pressure setting, P_2, for pressure settings from 0 to 2.5 psig has been found to be demonstrated by the curve in Figure 2.4-2.[7] The breathing losses are given as percentages of losses from atmospheric tanks.

2.4.2 Working Emissions

Working losses in low-pressure tanks occur when the pressure of the vapor space exceeds the vent setting during filling and vapors are expelled.

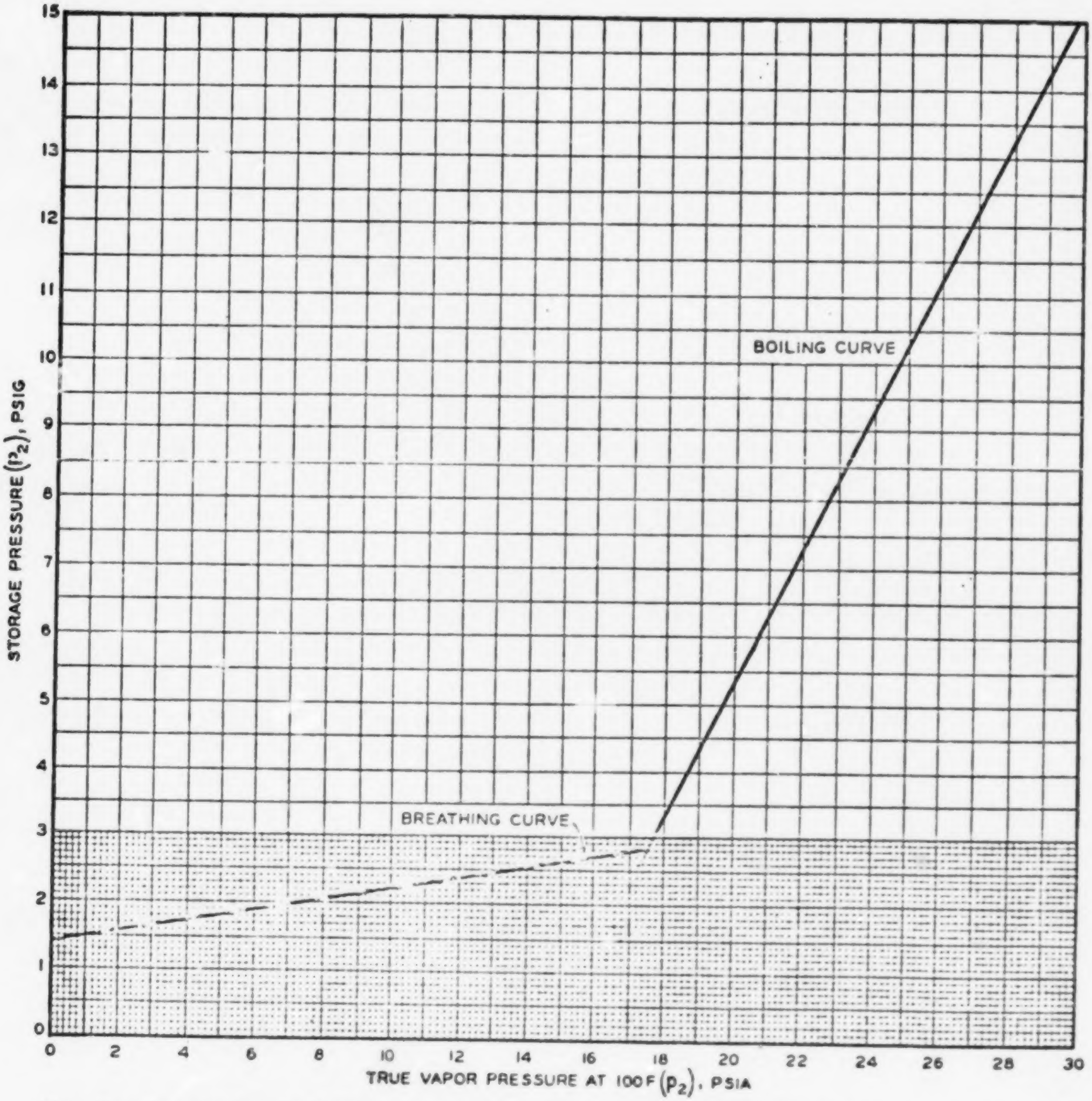
Calculation of working emissions from low-pressure tanks is complicated by temperature changes due to condensation. As a result, two assumptions are made:

(1) Vapor and liquid phases are in equilibrium

(2) Filling begins at slightly less than atmospheric pressure.

The resulting equation[7] for L_F, working emissions, is

$$L_F^1 = \frac{3p_v(P_a - P_1 - p_v)}{100(P_a + P_2 - p_v)}$$



Note: For values of p_1 between 20 and 30 psia, multiply the Reid vapor pressure at 100 F by 1.07.

FIGURE 2.4-1 - STORAGE PRESSURE REQUIRED TO ELIMINATE BREATHING AND BOILING LOSSES

TABLE 2.4-1

ATMOSPHERIC PRESSURE AT ALTITUDES ABOVE SEA LEVEL

Feet	Pounds per Square Inch Absolute
1,000	14.17
2,000	13.66
3,000	13.17
4,000	12.69
5,000	12.23

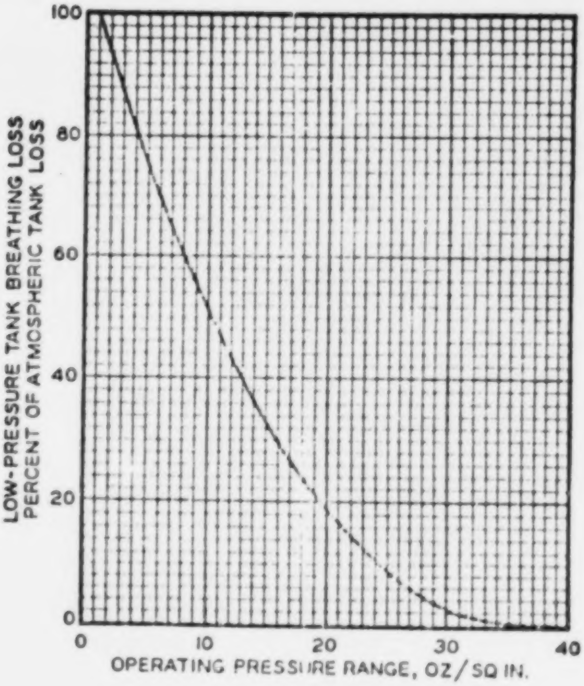


FIGURE 2.4-2 - RELATIONSHIP FOR ESTIMATING MOTOR GASOLINE BREATHING LOSS FROM TANKS OPERATING AT LESS THAN THE RECOMMENDED 2.5 PSIG VENT SETTING

where

L_F^1 = working emissions, % of volume pumped.

P_V = true vapor pressure at liquid temperature, psia.

P_a = atmospheric pressure, psia.

P_1 = gage pressure at which vacuum vent opens, psig (see 2.4.1).

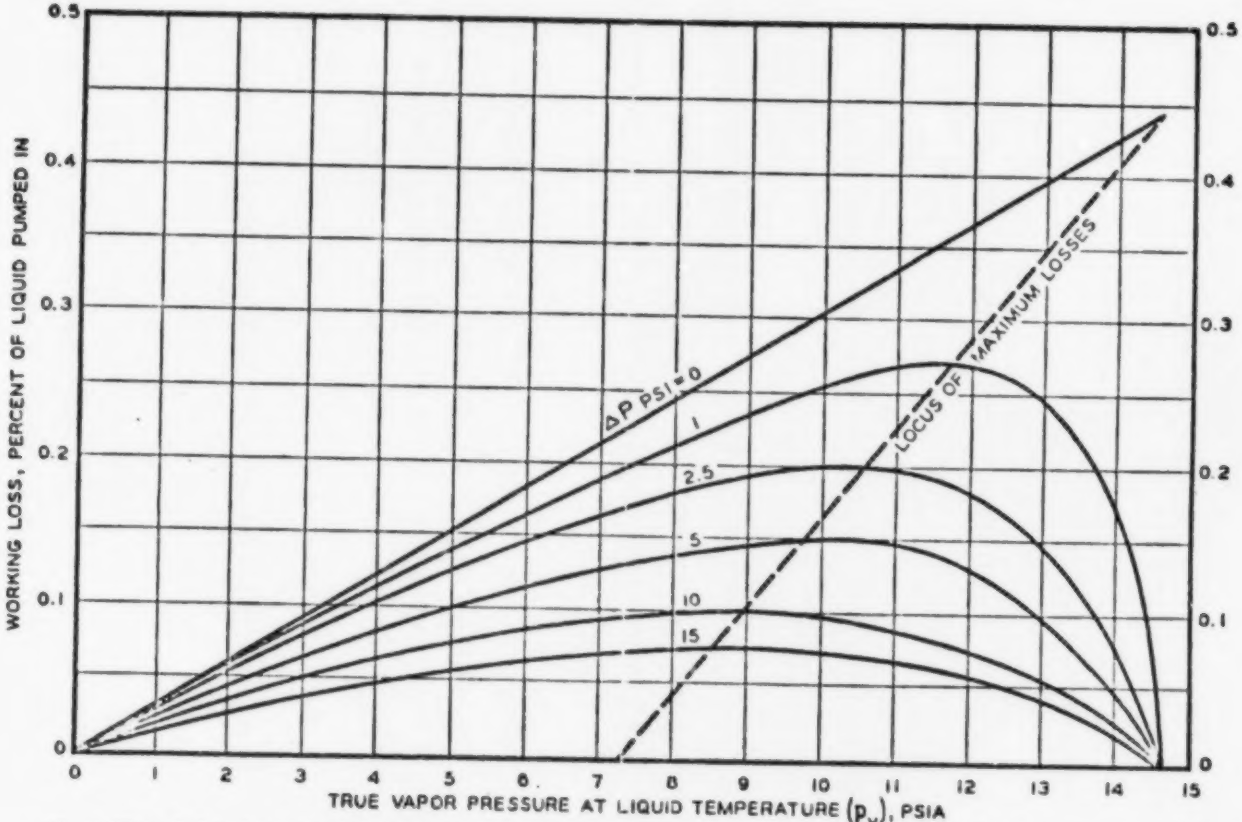
P_2 = gage pressure at which pressure vent opens, psig.

In Figure 2.4-3, emission values are shown for various vapor pressures, with pressure vent settings greater than the pressure required to prevent breathing losses. Twelve turnovers per year are assumed.

When the pressure vent setting is equal to the pressure required to prevent breathing losses, no pressure rise is available to reduce working loss, and working losses may be calculated from Figure 2.2-5, assuming an equivalent fixed-roof tank.

2.5 Determination of Emissions from Underground Storage Tanks

Filling losses from service station underground storage tanks are highly dependent on such variables as pipe and tank diameters, temperature and vapor pressure of the gasoline, vent pipe size and length, and method of filling. In a study performed by Robert L. Chass and others of emissions



Note: Chart is based on equation (3a). ΔP is the difference between the pressure vent setting and the pressure required to prevent breathing loss as determined from Fig. 5 and as discussed above.

FIGURE 2.4-3 - LOSS IN PERCENT OF VOLUME PUMPED INTO TANK FOR VARIOUS VENT SETTINGS

from service stations in the Los Angeles area, the only factor varied was the method of filling.[2]

In order to complete the study, the truck was adequately sealed and there was a vapor recovery system at the bulk loading terminal. The resulting emission factors are shown in Table 2.5-1.

Additional working losses occur when fuel is pumped from the underground tank to the car. As gas is removed, air is inhaled and expands as it becomes saturated with vapor. As it expands, vapor is exhaled, and this process occurs until equilibrium is achieved. The emission factor for this process was found to be 1 lb/1000 gal gasoline pumped.[2] Forty percent gasoline vapor in the exhaled mixture was assumed.

Breathing losses in underground tanks are negligible due to small temperature changes.[1]

2.6 Determination of Emissions from Tank Cars or Trucks

2.6.1 Splash Loading

Splash loading occurs when the entry point of liquid lies above the surface level of the stored fluid. Estimates of emission losses during splash loading of tank cars or trucks may be made using an emission factor of 12.4 lb/1000 gal transferred.[3]

A more precise value may be obtained using the following equation[3]:

$$L_{sp} = \frac{(1.023 \times 10^{6})W}{(690 - 4M)T} \left[\frac{14.7 - YP}{14.7 - (0.95)P} - 1 \right]$$

TABLE 2.5-1

GASOLINE VAPOR LOSSES FOR DIFFERENT TYPES OF UNDERGROUND TANK FILLING TECHNIQUES

Type of Fill	Loss (lb/1000 gal pumped)
Splash	11.5
Submerged	7.3
Vapor return-open system	0.8
Vapor return-closed system	0

L_{sp} = splash loading loss, lb/1000 gal.

W = density of hydrocarbon liquid at temperature T, lb/gal.

T^1= bulk absolute temperature of organic liquid, °R.

Y = fraction of saturation of hydrocarbon in vapor space at time of loading.

P = true vapor pressure of the blend at temperature T, psia.

M = molecular weight of liquid, lb/lb-mole.

For a correlation between true vapor pressure and losses, see Figure 2.6-1.

2.6.2 Submerged Loading

The accepted emission factor for submerged loading of tank cars or trucks is 4.1 lb/1000 gal transferred.[3]

Accuracy within ±25% may be obtained by the equation

$$L_{sub} = \left(\frac{1.00-Y}{2}\right)\frac{69,600\ PW}{(690-4M)T'}$$

where

L_{sub} = submerged loading loss, lb/1000 gal of liquid loaded.

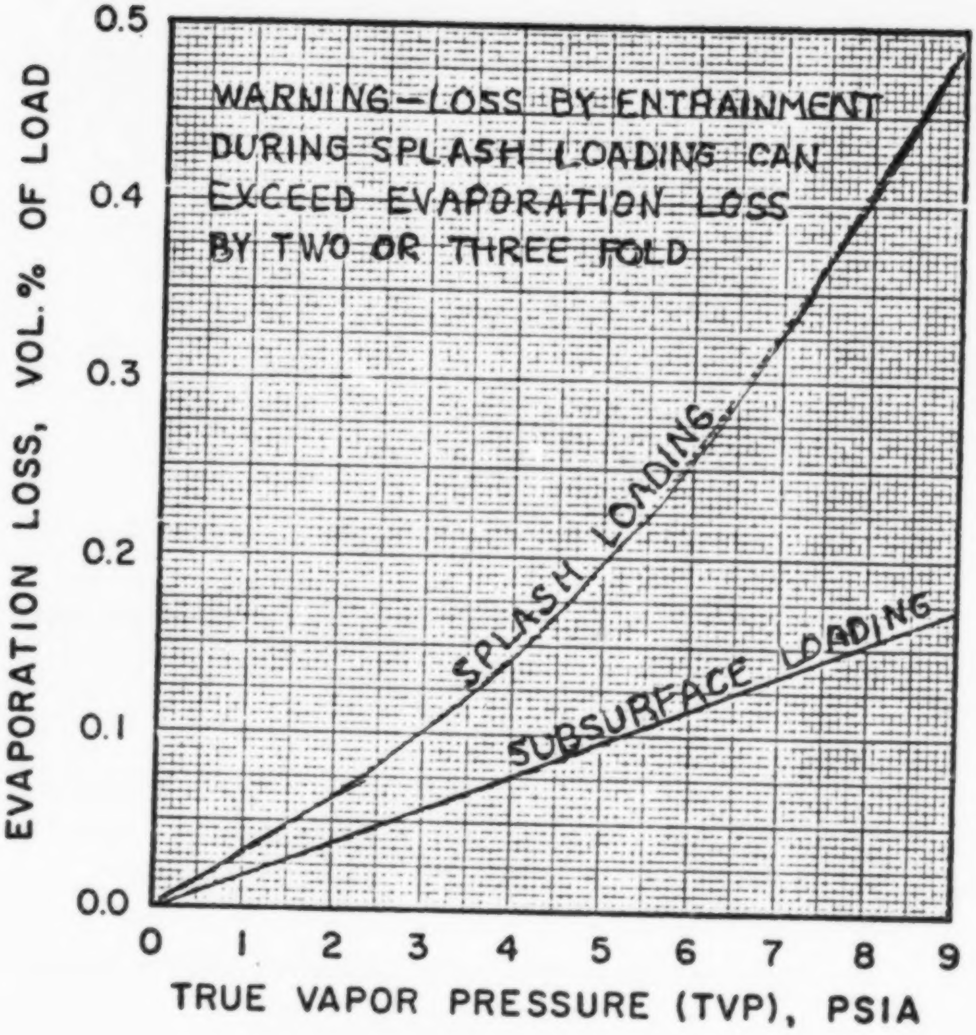


FIGURE 2.6-1 - LOADING LOSSES FROM MARINE VESSELS, TANK CARS AND TANK TRUCKS

Y = fraction saturation in tank before loading.

P = true vapor pressure of blend at temperature T, psia.

W = density of hydrocarbon liquid at temperature T^1, lb/gal.

T = bulk absolute temperature of liquid, °R.

M = molecular weight of liquid, lb/lb-mole.

For a relation between true vapor pressure and losses, see Figure 2.6-1. Figure 2.6-2 provides a correlation between temperature, Reid Vapor Pressure, and filling losses for 50% submerged loading.

2.6.3 Unloading Losses

Unloading losses from tank trucks and cars occur when air enters the truck and evaporation occurs. The vapor expands and is expelled until equilibrium is reached. An accepted emission factor for unloading tank cars and trucks is 2.1 lb/1000 gal transferred.[3]

Accurate to within ±10% is the following equation[3] for calculation of unloading losses from tank cars and trucks:

$$L_u = \frac{69,600\ YPW}{(690-4M)T'}$$

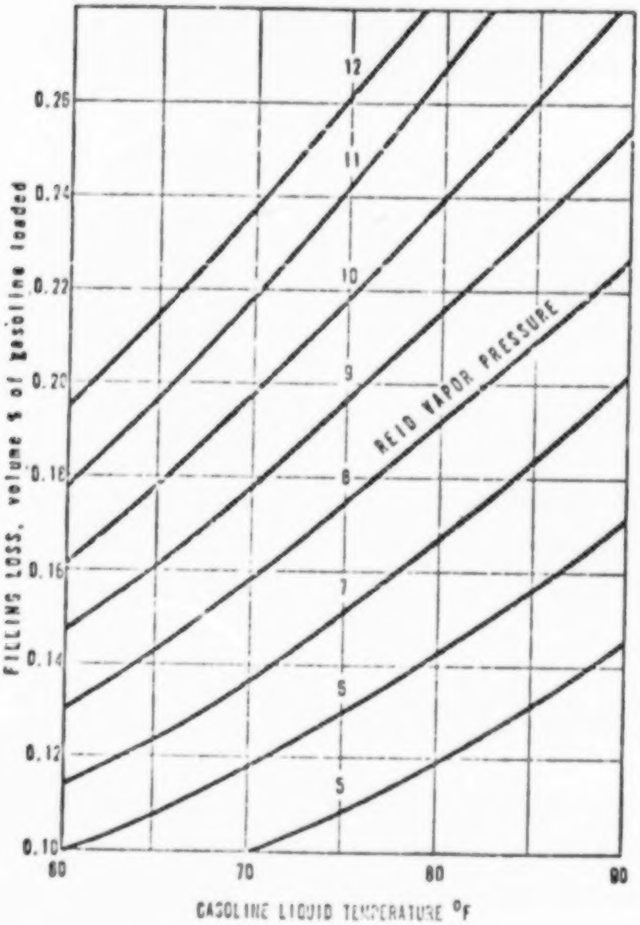


FIGURE 2.6-2 - CORRELATION OF TANK VEHICLE-LOADING LOSSES (50% SUBMERGED FILLING) WITH REID VAPOR PRESSURE AND LIQUID TEMPERATURES OF THE MOTOR GASOLINE

where

L_u = unloading loss, lb/1000 gal of liquid loaded.

Y = degree of saturation of organic blend in vapor space at time of unloading (estimated or measured).

T^1= bulk absolute temperature of organic liquid, °R.

P = true vapor pressure of blend at temperature T, psia.

M = molecular weight of liquid, lb/lb-mole.

W = density of hydrocarbon liquid at temperature $T,^1$ lb/gal.

2.6.4 Transit

Transit breathing losses from tank cars and trucks are assumed to be negligible due to the short travel time.[3]

2.7 Determination of Emissions from the Filling of Vehicle Gasoline Tanks

2.7.1 Vapor Loss

Vapor loss incurred during filling of motor vehicle gasoline tanks may be estimated by an emission factor of 11.0 lb/1000 gal. pumped.[3]

An expression[3] accurate to within ±0.5 lb/1000 gal for the calculation of these losses was formulated by Scott Research, Inc.:

$$L_D = 2.22 \exp(-0.02645 + 0.01155\ T_{DF}$$

$$-0.01226\ T_v + 0.00246\ \ T_v\ P_{RVP})$$

where

L_D = vapor loss, lb/1000 gal.

T_{DF} = average dispensed fuel temperature, °F.

T_v = average temperature of vehicle tank vapor displaced, °F.

P_{RVP} = Reid Vapor Pressure of gasoline pumped at temperature T_{DF}, psia.

2.7.2 Liquid Spillage Loss

The average emission factor for liquid spillage has been found to be 0.67 lb/1000 gal pumped.[3]

2.8 Determination of Emissions from Marine Vessels

Tankers and barges, due to their large capacities, are the source of major hydrocarbon emissions. Losses occur during loading, transit, and unloading. Emissions may be minimized by careful carrier design.

Unloading losses may be estimated by the analogous shore-tank withdrawal losses, that is, -0.007 percent by volume per psia true vapor pressure of the blend.[10]

Transit losses have been shown by limited data to be roughly 0.01 percent by volume per psia true vapor pressure of the blend for a one-week voyage.[10]

Although a limited amount of data is available, it is thought that loading losses from marine vessels may be estimated by a factor of 0.008 percent by volume per psia true vapor pressure of the blend for ships relatively vapor free.[10] For ships having a significant amount of existent vapor, the loss would be lower.

A correlation for losses during loading of relatively vapor-free ships is found in Figure 2.8-1.[6] Loading losses are minimized when fill pipes are an integral part of the carrier and are arranged to minimize splashing.

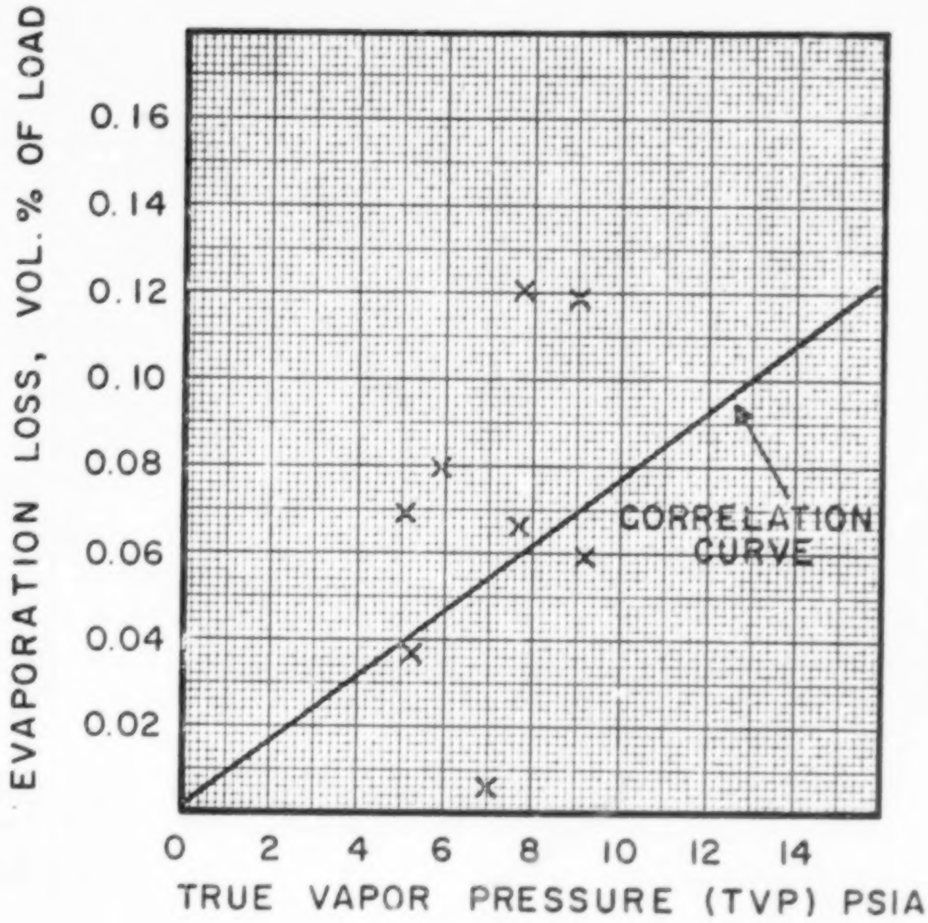


FIGURE 2.8-1 - LOSS FROM LOADING TANKERS AND BARGES

3.0 DEFINITION OF TERMS

Breathing Loss - vapor loss due to expansion and contraction of vapors as a result of alternate heating and cooling.

Filling Loss - loss due to the expulsion of vapor as liquid is charged to the vessel.

Outage - the vertical distance between the liquid is a tank and the top of the container.

Splash Loading - Filling which takes place with the entry of the liquid above the surface level of the stored fluid. Splash loading encourages evaporation due to the boiling effect that takes place.

Standing Storage (wicking) Loss - loss caused by the capillary flow of the liquid between the seal and the tank wall in floating-roof tanks.

Turnovers per year - annual throughput divided by tank capacity.

Withdrawal (wetting) Loss - evaporation that results when the wet tank walls are exposed to air as liquid is withdrawn is floating-roof tanks.

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16. ABSTRACT

Background information is given on the size and extent of the gasoline marketing industry and the magnitude of hydrocarbon vapor emissions. The principal sources of emissions, tank truck filling at bulk terminals, service station storage tank filling and vehicle refueling are characterized. Vapor control techniques for bulk terminals are described: compression, refrigeration, absorption, adsorption, incineration, and combinations of these techniques. The two types of control systems for service stations are evaluated, vapor balance systems and vacuum assist/secondary processing systems. Test data are given.

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